ENGINEERING

ECIAL RECORD
F ENGINEERING NEWS
om 19 June to 7 August

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Philosophy of Structures
eviewed

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Calibrating Flow Recorders

THE UNIVERSITY OF MICHIGAN
SEP 3 1959
ENGINEERING

XUM

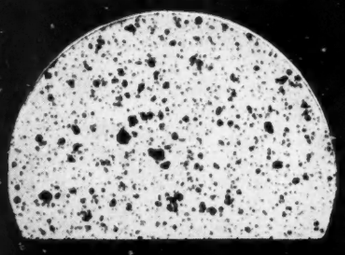
What is filter *Stability?*

A filter should do its work with equal efficiency throughout its working life. It should be *stable*. The C.A.V. paper element fuel filter continues to work efficiently right up until it is finally choked.

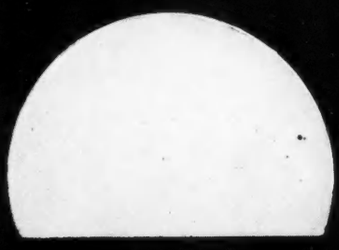
Many filters on the market do not, however. On test, they may start by showing a fair efficiency, but later, more and more of the abrasive particles pass through the filter material. Such unstable filters are quite useless, and are no safeguard to your fuel injection equipment whatsoever.

These photomicrographs of fuel tell the story of actual tests.

STABLE



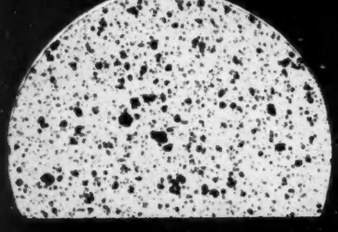
1 Fuel laden with abrasive dust, before filtration



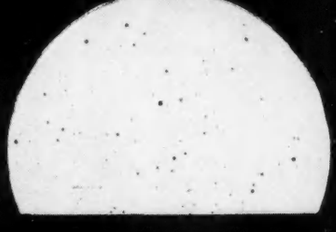
2 The same fuel after passing through a C.A.V. paper element filter at beginning of test

3 Fuel after filtration by the same element when all but choked by waxy sludge and dirt

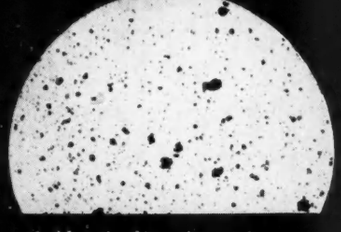
UNSTABLE



4 The same fuel is used for this test



5 At the beginning of test, filtration is fairly efficient



6 After the filter element is partly choked, the fuel passing through takes with it nearly all the particles of dust

There is only one genuine C.A.V. paper filter element. Substitutes are frequently unstable

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ENGINEERING

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ENGINEERING *Appointments Section faces page 32*

Something for Nothing?

THERE are, according to economists, three factors of production: land, in the broadest sense, labour and capital. But the land with its resources may be remote, the labour unskilled or inaccessible, and the capital in someone's sock. Management is the activity that brings these factors together and makes them fruitful. Conversely, management is what remains of the production process when all the tangibles have been removed. But if in isolation management is intangible, can it be said to exist at all? And if it does, can it be usefully taught outside the context of its subject matter?

It is difficult to see the common managerial element in managing a steelworks and managing a farm. Certainly, the same qualities will be found in the men who manage: native intelligence and understanding, a reasonable authority, and the power to accumulate and profit from experience. But these are personal qualities useful equally in, say, a politician, a detective, or a father. No doubt a man who proves a good manager in one field will be equally successful in another, but the reason may be simply that he is a good man, not a good manager. He will also be good at getting his children off to bed at the appointed time.

Management, therefore, if it is to be considered a genuine separate field of study, must be defined by something else. The key, if any, may lie in the nature of the experience which the manager acquires.

The British Iron and Steel Federation in establishing their management college at Ashorne Hill have clearly taken experience as the cardinal principle of management training. Courses are devised to cram a lifetime of experience into a few energetic weeks. The method of case study has been expanded to embrace complete development projects, for example, the reorganisation of a works; and the student spends much of his stay in Warwickshire tackling the constituent problems of such a situation.

The authors of these courses have wisely avoided the question whether management can be isolated. The training is soundly based on iron and steel making and the manufacture of iron and steel products. Whether or not management exists as an abstraction, it is surely better to train those destined for the steel industry in the management problems peculiar to that industry. It remains open whether such training would impart more than a marginal advantage to someone who subsequently joined the electronics industry or became an editor.

The extent to which courses at Ashorne Hill are concerned with the subject matter of iron and steel may be gathered from a typical project. Details are given of a fictitious Manor Park Steel Company, including a full account of its resources in plant, manpower and finance. The syndicate of nine students would be required to propose plans whereby the present capacity of some 8,000 ingot tons per week could be increased to 20,000 ingot tons with a capital expenditure of about £2 million. The 20 page report produced by one syndicate included full logs of furnace operation and manning, capital expenditure schedules, and detailed drawings indicating the proposed redesign of existing furnaces, and a revised layout of the works.

Each course is residential and arranged to include 27 members broadly representative of the various functions of management in the industry. Thus a suitable balance would be given by nine members of production departments, six from engineering and maintenance departments, three from accounts, three from research and six from other departments such as labour, welfare, education, commercial, general offices, fuel engineering and traffic. An eight-week course, which is divided by a ten-week interval, costs £200, and a three-week course £75. Instruction is extended to case studies (concerned with people rather than plant or processes), safety, sales, costing, work study, operational research and statistical method.

This is clearly management training with no nonsense. Possibly management can be taught in no other way. In that case smaller industries with limited resources may be obliged to tackle management training through the hard school of working experience. Notwithstanding the existence of various institutions devoted to the practice and study of management, to detach it from its working materials, like abstraction in painting, is to introduce obscurity.

Yet, taking the economist's three factors once again, there must be something else that transforms them. Management, the economists may argue, is merely a component of the labour factor, the brain component. But it cannot be measured in man hours: a moment's inspiration may double the revenues of a steelworks. Labour, capital and materials alone are valueless. We may employ a man, invest in a chisel for him to use, provide him with some stone to shape, and the product may be worthless. But find the right man and the product may be priceless. The increase, the ability to maximise the return on a given combination of assets, this is the measure of management. Management is a way of getting something for nothing—or almost nothing.

Cover Picture.—*Single-point industrial flow recorders are shown being calibrated against known heads. This is done before the instrument goes for the final inspection prior to despatch.*

(*Nurnberg photograph for* ENGINEERING)

Plain Words

To arrive at a theatre with the wrong ticket, or at a frontier without a visa is provoking. To face the modern world with the wrong qualifications—or possibly with none at all—is immeasurably worse. I grieve to think how much talent we are wasting.

Signs of the times accumulate: the mushroom growth of specialist societies, specialist journals, mysterious letters-after-the-name, esoteric jargons—some of them eclectic enough to rank as private languages. Associations set up for the simple and laudable end of providing a common forum for people with a common interest, whether professional or private, are now busy closing their ranks and crying "I spy strangers" when non-members poach on their preserves. The Purchasing Officers Association once welcomed anyone engaged in industrial purchasing; now you can't get in under 37 without a five-year examination course. The British Interplanetary Society was once content to cater for the interests of members ranging from mathematicians interested in minimum energy trajectories to men who liked messing about with little rockets—or designing big ones. Now it seems to be exploring the trackless field of membership grades; two last year, three this year, a fourth under consideration. But there is a graver symptom: an exclusive, even smug, attitude among those whose own qualifications, like Caesar's wife, are above suspicion.

Engineers, of all people, ought to respect the non-specialist; even the anti-specialist. Was Michaelangelo a specialist? Or take Brunel; his talents were ready for anything—Thames tunnelling, railway layout, station architecture, locomotive design, steamship construction, watercolours. Then there's the shocking case of Nicholas Christofilos. He was a Greek electrical engineer working on lifts at the time he thought up the strong-focusing principle for high-energy accelerators. At present he is working on thermonuclear research at Livermore Laboratory. He still has no degree in physics.

Some adverse comment has been made in engineering circles about architects trespassing on the preserves of the engineer. It reminds me of Arthur Koestler's remark: "This age of specialists is in need of creative trespassers." And the question is not: "Was this designed by a properly qualified man belonging to the right professional body?" It is: "Is this a good solution to the problem; does it work?"

On the other hand I am reminded of a friend, who, while working on the railways secured his Ph.D. No word of praise came from his superior; only "You'll have to live it down."

CAPRICORN

Weekly Survey

A Flight of Birds

The excellent summer weather has been accompanied by equally good indications of strong economic recovery—a flight of figurative birds to serve as an auspicious omen. During July the gold and dollar reserves increased by £17 million after paying off £7 million for debts left over from the European Payments Union. July is normally the month when pressure builds up against sterling but there has been no sign of this during the present summer and sterling remains exceedingly firm on all foreign exchanges.

Economic recovery is now setting in strongly both at home and abroad. The National Institute's *Economic Review* for July considers that the pace of recovery at home is faster than expected. Industrial production is rising, and at the present time is outstripping the increase in employment. This is because output per man, especially in manufacturing, has increased sharply. Recovery has been most marked in vehicles, electrical engineering, building and to a lesser extent in textiles and clothing. It has not yet spread to shipbuilding or mechanical engineering. This last is heavily dependent on investment demand which is still lagging. Steel output is increasing, but there is as yet no sign of recovery in coal.

According to the review, recovery is now under way strongly in the rest of Western Europe, and the increase in British exports of recent months has been mainly to industrial countries, including of course the United States. The exports of primary producing countries have stopped falling and this is a propitious sign for the long term expansion of British exports.

One of the features of recovery so far is undoubtedly the contrast between the trend of output in electrical engineering and in mechanical engineering. Electrical engineering has benefited from the rise in demand for consumer durable goods. The decline in mechanical engineering is quite significant. Comparing the first quarter of 1959 with the same quarter of 1958, mechanical engineering showed a drop of 5 per cent. This performance is due primarily to the fact that the demand for mechanical engineering equipment comes mainly from private industry, and recovery there has still some distance to go. It is engineering companies whose customers cater for durable consumer goods or who supply public utilities and public corporations which have done best in the recovery so far.

Computers Misused

According to Mr. J. A. Goldsmith, speaking at the British Computer Society's conference at Cambridge, the use of computers in this country is unambitious and below their capacity. Most computers are used on payroll work, and after that stock control is the most popular application. With unambitious use of these machines goes a certain amount of misuse. Other types of calculator could do some of the work for which computers are being used. The most disappointing feature so far was the slow progress being made with computers on production control systems.

Putting Our Brains in a Satellite

The recent talks in Washington between the National Aeronautics and Space Administration of America and the British team headed by Professor H. S. W. Massey have resulted in an arrangement for British instruments to be put into orbit in two years time. They will be launched from the United States in an American rocket, the Scout. This rocket will not be available for firing for two years and this is the period of time which it will take to prepare the instruments which are costing between £100,000 and £200,000 a year for a four-year period.

The Americans will pay for the entire satellite project except for the instruments. They will be responsible for casing the instruments and for the transmission equipment and batteries. The total load will be about 150 lb. The offer by the Americans is for at least three satellites.

Planning the experiments which the instruments will carry out has already begun and in six months time there should be ten groups working on them. There may be as many as ten or more experiments—three or four different experiments in each of the satellites. It is not proposed to send up either animals or men.

Inner and Outer Trade Areas

The Stockholm draft plan for a European Free Trade Association of the "Outer Seven," has now been published as a white paper, called *Stockholm Draft Plan for EFTA* (HM Stationery Office, price 1*s*). The seven have agreed to an initial reduction in tariffs of 20 per cent by 1 July, 1960, and the elimination of all tariffs is to be completed by 1 January, 1970. Certain safeguards have been written into the draft, including the taking of defensive measures if any member runs into balance of payments difficulties. A Danish proposal on agriculture is added to the draft at the end.

There are signs that Germany continues to view with some apprehension the alliance of Scandinavia and the United Kingdom in a tariff system from which she herself is at least temporarily excluded. The French, who chose at first to ignore the Stockholm negotiations, have been somewhat impressed by the amount of progress which has been made and have taken up a generally hostile view to the association. There is little doubt that the first reaction to the plan to set up a Free Trade Association is to harden the line of demarcation between the association and the European Common Market. How dangerous for the future economic unity of Western Europe this cleavage might become remains to be seen.

Meanwhile, the European Common Market is showing signs of flexibility in membership. Greece has requested associate membership of the ECM and this has been accepted in principle. Turkey has also indicated that she is interested in acquiring membership. There is thus every indication that the economic grouping in Western Europe is going to cut across the political grouping. The members of NATO are spread over both economic organisations and the argument is increasingly persuasive that OEEC must be maintained, at least on a modified basis, if the danger of economic and political disintegration in Western Europe is not to increase.

American Oil Quota

Oil imports into the United States, the world's biggest importer, were put under compulsory quota arrangements earlier this year. The effect of the new contracts was to cut the total United States oil imports for the 3½ months up to the end of June by some 12 to 13 per cent of last year's figure of 1·7 million barrels per day. In the second half of the year the permitted rate of imports will be at about this level. What are the effects of this cut likely to be on oil exporting countries?

For the rest of this year they will export to

the United States at an annual rate about 10 million tons below last year's. This figure represents about one third of the increase in crude oil production last year in countries of the free world other than the United States. The biggest cuts will be in refined products and here Venezuela will be the main sufferer. It is estimated that its total exports to the United States will fall by around 7½ tons a year. This drop could be greater if some United States importers look for cheaper sources of crude elsewhere.

The new controls also put an end to Canadian hopes of increased exports to the United States. For the present at any rate the effects on the Middle East will be small, in fact something of the order of 2 million tons a year. Imports from the Far East are unlikely to be much reduced as these go to the West Coast where the quota for imports of crude is higher.

The basic argument used to justify control of oil imports is that too great a dependence on foreign supplies is unwise on grounds of national security. If the demand for oil in the United States continues at present rates however, home resources will need to be augmented by imports in the next 10 or 15 years. The immediate effect of the new policy may be to bring about a greater measure of national self-sufficiency. But unless the discovery rate is greatly increased or other sources such as indigenous shale oil production are developed, the United States will become increasingly dependent on oil imports in the years ahead.

Mission from the Caribbean

At the invitation of the Federation of British Industries, a trade mission has been visiting this country from the Federation of the West Indies and from British Guiana. Its purpose is to interest British manufacturers and potential investors in the industrial development of the Federation and British Guana as well as to discuss general trade questions. The mission is to visit the provinces and it should provide a useful opportunity for manufacturers to meet representatives from an area which has never been over-burdened with sales representation from this country.

Mechanics of Paralysis

A committee has been set up to tackle the problem of the disabled, from a combined engineering and medical point of view, by the National Fund of Poliomyelitis Research, whose patron is the Duke of Edinburgh. The fund's secretary, Mr. Duncan Guthrie, explained that once therapy, in the ordinary sense of doing treatment or exercises, had done as much as possible, a new approach was essential: "The facts remained medical; their solution often lay in the engineering field."

The new committee for research into apparatus for the disabled plan to sponsor the reassessment and analysis of basic problems in the fields of physical disability and the development of apparatus by doctors and engineers working together. "There is an urgent need," said Mr. Guthrie, "to discover how far the physical capabilities of the individual patient and his nursing can be improved by utilising modern engineering methods and resources of industry."

The fund has made a grant of £19,120 for an initial three year period and has appointed, at the Institute of Orthopaedics, a materials handling engineer, Mr. Denis Dalrymple. Drawing office and extra workshop staff are being selected. Several projects have been initiated, including a mechanism by which a paralysed limb may be operated by a healthy man. There will be a number of studies in limb action, and efforts will be made to improve the "ironmongery".

Slower Growth of Air Traffic

In 1958 the rate of increase in air traffic was about 4 per cent compared with an average rate of increase of 15 per cent over the last six years. Individual countries show very different performances. On scheduled services revenue traffic for the United States went up by only 1 per cent, in the United Kingdom by 6 per cent, but in the case of Belgium by as much as 33 per cent. Such figures suggest that some airlines benefit notably at the expense of others.

Target for Sahara Oil

A report has been made to the French National Assembly by M. Soustelle about the present rate of progress in the development of oil resources in the Sahara. Crude reserves are now of the order of 650 million tons and other oil-bearing regions have been discovered. The Sahara has, of course, other natural resources as well as oil, such as iron, manganese and certain other metals.

The key to development at the present time is transport. When the 24 in pipe from Hassi Messaoud to the Mediterranean is opened this autumn there should be an immediate flow of oil at a rate of about 4 million tons a year. This is to be raised to 40 million tons by 1962 with the construction of further pumping stations, and by 1963 the pipeline from Edjele to the Gulf of Gabes will be in use. By that time the Sahara should be providing France with all its oil needs. By 1965 it is hoped to be extracting crude oil at the rate of 50 million tons a year for refining in metropolitan France.

Beyond that date the question will arise of how France is to dispose of the Sahara's exportable surplus. The years 1963 to 1965 may not be very propitious for opening up export markets. The Russians will by then have had the first five years of the new Seven Year Plan and under this plan the Soviet intends to double its rate of oil production. There have already been indications that Russia would be glad to sell oil on the the world market in the early years of the Seven Year Plan as the Volga oilfield becomes further developed. Russia and France may therefore come into the export market on a large scale at about the same time. Since the oil reserves of the Middle East still show no signs of having reached their maximum figure this area too may be under pressure to find new markets.

Orders for British Railways

Orders worth £290,000 for about 95 miles of electric cables and accessories have been placed by British Railways for its electrification programme. The areas affected are London Midland Region, Scottish Region and Eastern Region. Companies to benefit from the orders are British Insulated Callender's Cables Limited, Pirelli-General Cable Works Limited, W. T. Henley's Telegraph Works Company Limited, Enfield Cables Limited, Aberdare Cables Limited and Siemens Edison Swan Limited.

Plastics Go Ahead

In the first quarter of 1959 the output of plastics continued to expand although the rate of increase was less than in the last quarter of 1958. Sales of thermosetting materials were in fact slightly down on the quarter although higher than in the first quarter of last year. Sales of thermoplastic materials, however, increased by as much as 14 per cent on the quarter. Much of this increase was in polythene and the first quarter of this year was marked by the coming into operation of the new Monsanto polythene factory at Fawley.

Letters to the Editor

STEPLESS VARIATION?

SIR, A century of endeavour has produced no positively-driven continuously-variable mechanical gear. Will any mathematical engineer kindly prove that the whole concept is impossible, in the realm of trisected angles and self-elevating bootlaces—or is the search still worth the devotion of such innocents as myself?

Yours faithfully,

ERIC H. VOICE.

31 Sweyn Road,
Thurso, Caithness.
3 August, 1959.

RENEWING BOOK LOANS

SIR, It is difficult for an industrial librarian to grasp why a printed request for renewal of loan should arouse so much ire in Mr. Frank Smith's soul. (On the Shelf, ENGINEERING, 5 June, page 745.)

Admittedly, it is the librarian's fuction to anticipate his customers' needs as far as possible and to have the material to hand, but for an industrial librarian to anticipate every user's every future demand would require a high degree of clairvoyance. Even assuming that he had that quality, and also had at his disposal an unlimited budget and unlimited space (which is just as unlikely) there would still remain those out-of-print or otherwise difficult items for which he would have to rely on outside loans. In any case, if each library is expected to be self-sufficient, why should a National Lending Library be considered necessary, and why maintain the existing services of the Department of Scientific and Industrial Research, the Technical Information and Library Services (TIL) of the Ministry of Supply, the Science Library, the Regional Library Bureaux, and other similar organisations?

Of course borrowed material should be returned within the specified time if possible, but difficulties are bound to arise, particularly in industry, as, for example, a prolonged research task, changed priorities of work, or sick leave. In such cases, an application for an extension of the loan period (printed or otherwise) is common practice and courtesy, and does not imply that the librarian is relegated to a "clearing house."

Yours faithfully,

A. R. ANDREWS.

17 Edward Street,
St. Anne's-on-Sea, Lancs.
9 June, 1959.

VIRTUAL WORK

SIR, May I make some comments on the article "Virtual Work and Complementary Energy Applied to Non-Linear Braced Frameworks," by Professor J. A. L. Matheson, published on page 581 of your issue of 1 May last?

In the analysis of hyperstatic structures, the use of complementary energy forms a powerful method of attack. The common strain energy theorems, valid for linear structures only (equations 1 and 2 of the original article), are, in fact, only particular cases which can be obtained from the more general complementary energy theorems (equations 3 and 4). Strain energy methods are not, however, restricted to linear structures. The principle of virtual work, used in this article to solve a non-linear problem, is based on equating the strain energy during a small disturbance to the work done by the external forces; it is a strain energy theorem which is the inverse of equation (3), conservation of energy being taken into account.

If the redundant members of a structure are cut and quasi-external forces applied across the gap to close the cut, then equation (4) can be used to ensure that compatibility is satisfied. To apply this method conveniently, deformations must be explicitly expressible as functions of forces. Many practical problems of this type arise. Buckling of columns is an example. Curved load-deformation relations can be

handled, and the method is not restricted to relations which are a series of straight lines.

Professor Matheson has solved a problem in which the stress-strain curve has two branches in both tension and compression. He shows that incorrect solutions can be obtained by lack of careful attention to signs. The trouble is avoided if the modulus sign is discarded and the stress-strain curve relation is *algebraically* defined in the three relevant regions, strain being expressed as a function of load. Integration gives the complementary energy in terms of the load, this load being expressed in terms of the external forces and the load in the redundant member, using statics only. Differentiation and the use of equation (4) give the solution. It is necessary to pick the regions in which the solutions lie, in order to decide which complementary energy expression to use. This is not obvious in the present case (though in many cases it is obvious). If the incorrect region is chosen, the solution lies outside the region and compatibility is not satisfied. As a final check, the equation of the rigid beam must be satisfied. It may be mentioned that energy methods are, in fact, only a means to an end; they furnish a convenient method of writing down the equations of geometrical constraint.

A curved stress-strain relation is handled rather more easily, as no " guess and check " for the state of strain is necessary. It is easy to fit a third degree polynomial to the stress-strain curve given, and one expression for the complementary energy, valid for all states of strain, is obtained. The solution is direct, the non-linear equation obtained being easily solved.

Yours faithfully,
M. GREGORY.

Department of Civil Engineering,
University of Tasmania, Hobart.
21 July, 1959.

PYROTECHNICS ?

SIR, I hope I shall not be accused of something approaching a distortion of the apperception of Leibnitz, or of a misplaced zealousness in matters Braidwoodian, or again as disloyal to what contextually may be called " pure " engineering, if I remark that I am not sure as to the interpretation intended by Capricorn in his references to fire engines that " ululated " past, and more especially, to a thankfulness that there was to be no resultant special article on the technical features of fire-fighting—references appearing in his Plain Words of 12 June.

Firstly, the ululant feature of these engines on this particular occasion (they do not always ululate—and only rarely in England) was sufficient to set a-warring my reactions as one trained in engineering, professionally concerned with fire protection, and possessing humble journalistic qualifications. What was this ululation? It did not ring a bell, that at least I knew. If my etymology is sound, bells do not ululate, except perhaps by poetic licence. Should this ululated engine be common knowledge to me as say the reciprocating or the articulated? Those of us whose Latin is just a little more destitute than our English could not take a guess on it. Perhaps light amusement is the best reaction to this clear instance of a technical journalist's piratical intrusion in the lawful business of his literary superiors. But the entertainment value—for I am sure Capricorn intended to entertain—is enhanced (unintentionally?) by his remarks on " pitfalls," " cleverness," and " crummy stuff," but never so much as by the title of his ramblings.

But how refreshing is all this human inconsistency in a staid journal of hard science.

I am loath now to censure Capricorn, if indeed I can justifiably, for, as I said at the outset, I am not sure as to the implication of his remarks on the technical features of fire-fighting. Does he share his erstwhile colleague's seeming approach, that fire-fighting has little technical content, or does he, in mentioning that the " old man " had the right idea, apart from agreeing the need of a " technical eye," really appreciate that fire-fighting as a broad term for the prevention, detection, and extinguishment of fire, is a subject not beneath the good standing of his journal? The entirely technical field of detection, and that of the tools of extinguishment, the complexity of sound design of fixed installations due to the illusiveness of extinction mechanisms and the unknowns of fire behaviour, and above all the multiplicity of diverse matters that make up the all-important field of prevention, demanding in the preventionist an ever-increasing breadth of knowledge; any of these or their myriad subdivisions would be material for endless articles of the accustomed ENGINEERING standard.

With a national annual direct fire loss of some £25 million, most of it industrial, and a consequential loss which, if incalculable, is known to be greater, the subject of fire protection has a marked social and economic as well as technical import, and a considered presentation of it would perhaps go a little way towards reducing the too frequent reports of serious industrial fires.

Yours faithfully,
CHARLES E. FENNA.

43 Mornington Crescent,
Cranford, Hounslow.
3 July, 1959.

LEARNING TO TYPE

SIR, In your issue of 22 May, Capricorn in Plain Words suggest, that the time is right to press for the teaching of typing at schools. He said it would be so easy and such fun to learn typing at school.

I am of the opinion that there is far more to Capricorn's suggestion than appears on the surface, for I believe that ability to type at a reasonable speed would increase the effectiveness of hundreds of thousands of our more intelligent workers in many fields of activity and reduce the " overhead " costs of their work. It would also encourage many with creative minds to record their ideas. Although I am an engineer in charge of a £100 million organisation, I still regret that I did not acquire some skill with the typewriter and some knowledge of shorthand when I was young.

My own children—three of them—were girls with no intention of going into the business world, but I insisted upon them all learning typing in college. One became an honours Arts graduate at the university, one a commercial artist, and the third a teacher of arts and crafts, but they have all found their ability with a typewriter of very great value and have repeatedly thanked me for the training arranged for them.

As a graduate myself, I am convinced that typing and some knowledge of shorthand should be compulsory pre-requisites for any university course. In some countries, an examiner—quite rightly—refuses to read a thesis unless it is typed. Taking lecture notes in longhand ruins handwriting, wastes time, and leads to general untidiness which is almost a " hallmark " of the university man for the rest of his life.

My personal assistant is a graduate engineer with a knowledge of shorthand. He is invaluable, and greatly increases his and my own effectiveness; that is, the quality and extent of our work. Finally, I might mention that I know personally half-a-dozen men who have reached high administrative posts—one of them has been knighted, another received the I.S.O.—who would never have had opportunities for gaining experience and for advancement such as came to them if they had not accepted advice to learn shorthand when they were young.

Yours faithfully,
L. R. EAST,
C.B.E., M.C.E, M.I.C.E.,
Chairman.

State Rivers and Water Supply Commission,
100 Exhibition Street, Melbourne, C.I.
14 July, 1959.

TURBINE BLADES

SIR, May I refer to the article on " Blade Frequency of Turbines: Effect of Disc Elasticity," by J. P. Ellington and H. McCallion, published on page 645 of your issue of 15 May?

There is, as the authors state, comparatively little theoretical work available which considers the coupled vibration of turbine blades and discs though much has been written on the vibration of blades and discs as separate systems. Any attempt, therefore, at a theoretical approach to the problem is most welcome but its value can only be assessed by comparison of the model with the practical system it is intended to represent.

If we examine the model analysed by the authors in which motion is restricted to take place within the plane of the disc it is difficult to imagine a stiffer element than a disc resisting bending in its own plane. In such a case it would seem more reasonable to assume the blades to vibrate in phase and the inertia of the moving blades to be balanced by motion of the disc on its supports in antiphase with the blades. This is substantiated by the appearance of a node in the blades above the root fixing when blades on a turbine disc are vibrated at their fundamental frequency.

Suppose, however, we accept the authors' analysis and assume the disc to be only 20 times stiffer than the blades then equation (13) indicates a band of blade frequencies within $\pm$ 0·8 per cent of the mean frequency. If we consider the same disc but increase the length of the blades to twice their original length then the frequency " spread " is reduced to $\pm$ 0·36 per cent, i.e., doubling the blade length has more than halved the frequency " spread."

In practice, the frequency " spread " obtained with nominally identical turbine blades is seldom less than $\pm$ 5 per cent and this " spread " is usually attributed to variations in root fixing, manufacturing tolerances, etc., and in fact, considerable attention has been given to the design of blade fixings to minimise the variation in frequency of identical blades. In this connection, reference may be made to the article on " Turbine Blade Vibration," by F. Andrews and J. P. Duncan (ENGNG, 17 Aug. '56, p. 202). It is not surprising, therefore, that no appreciable reduction in the frequency " spread " is observed as the blade length increases, since the " spread " indicated by equation (13), especially if a more realistic stiffness ratio of about 100 is used, is so much smaller than the " spread " due to the causes mentioned above.

The majority of turbine discs do not have symmetrical blades which vibrate in the plane of the disc about their principal axes and those which have are generally the least troublesome and conform reasonably well to existing theory. Any attempt to determine the effect of disc elasticity on the frequencies of blades attached to it must take into account motion outside the plane of the disc since the rim is much more flexible in an axial direction than in its own plane. If motion outside the plane of the disc is allowed, the rim torsion as well as bending has to be considered and this will alter the character of equations (4). It is no longer obvious then, as stated by the authors, that the obliquity of the blading will not seriously affect the results given.

It would be most interesting to know whether the authors' method of approach could be adapted to the more difficult and very important problem of coupled disc and blade vibrations with nodal diameters and nodal circles. Any attempt at predicting this type of behaviour would be most welcome.

Yours faithfully,
R. FLEETING.

PAMETRADA Research Station,
Wallsend, Northumberland.
30 July, 1959.

PIPE LOADER
British Built Tractor with 6 ton Capacity

THE first British built pipe handling tractor is for use in the Niger Delta oilfields. It can handle 14,000 lb of tubes in lengths of up to 40 ft and load them on barges or lorries.

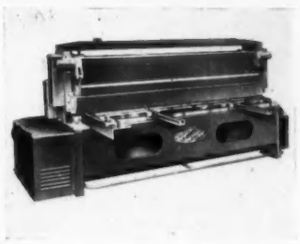
The machine, known as the Michigan type 175A pipe handler, will be used to speed up operations in the materials yard, at pipeline construction sites, and at drilling locations. The design load of 14,000 lb can be lifted and carried to the site as required.

The tractor can in addition be used to haul a pipe trailer with a load of up to 50,000 lb at speeds of 27 m.p.h., depending of course on the nature of the ground to be covered; thereby offering a considerable saving in time and equipment, as it can unload the pipes when in position and a second machine is not required.

Power is supplied by a Rolls-Royce type C4S supercharged diesel engine which drives through a torque converter, a power-operated gear change box to the four wheels. Power steering is also incorporated. Extra large tyres are fitted to enable it to operate on soft ground, the size being 18·00 by 25.

The pipe handling forks have been designed to give a forward tilt of 72° under hydraulic control, which allows the tractor to pick up pipes from a point 3 ft below ground level. This feature is very useful when barges are being loaded or unloaded as the tractor can then work from the bank in the majority of cases. If desired, the pipe handling mechanism can be removed, which enables the machine to function as a heavy duty fork lift truck. *Michigan (Great Britain) Limited, Camberley, Surrey.*

SHEARS
Capacity of 8 ft by ¼ in



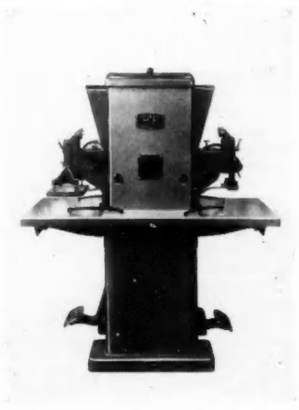
THE first model of a new range of Keetona shears has a capacity of 8 ft by ¼ in. It is also the first Keetona machine to have fabricated construction.

The plate to be cut can be held down by either mechanical or hydraulic clamps and the blades are accessible for changing. The upper cutting blade is set at an angle of 2° to the vertical, but the lower blade is set square to the table. This arrangement allows the corner of the blade to be presented to the work giving the same effect as using bevel edged blades. There is no risk of the sheared material being trapped between the lower blade and the back gauge as the latter moves away from the lower blade during cutting. A hand-operated micrometer back gauge is fitted.

The clutch meshes with the main driving gear and slides on the splined end of the crankshaft. At the end of the cutting stroke the clutch is automatically disengaged and remains so until the treadle is again depressed unless the operation is switched to continuous running by means of a plunger. The beam is fitted with counterbalance springs that operate on the return stroke.

The drive motor is rated at 10 h.p., 1,500 r.p.m., and together with the primary drive is contained in an enclosed casing. The worm gear unit has been specially designed to withstand shock and has heavy duty bearings to carry the high speed flywheel. Star-delta starting is used with remote control. On the 8 ft machine the front gauge range is 37 in, back gauge 30 in and throat depth 4 in. The machine is capable of 46 strokes per minute. *Keeton Sons and Company Limited, Keetona Works, Greenland Road, Sheffield 9.*

PLASTICS WELDER
Double Head High Capacity Machine



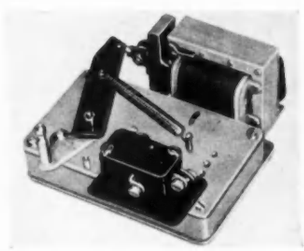
THE latest introductions to the Acme range of plastics welding machines are two models fitted with double heads. The smaller, No. 5, is rated at 2 kW and the larger, No. 6, at 3 kW.

Each of the heads functions independently and the positioning of the controls is the same for both operators. The presses are interlocked to prevent connection of the generator to both electrodes at the same time. One press may be in operation whilst electrodes are being changed in the other or an entirely different operation taking place.

Both models incorporate self lubricating bearings, lever adjustment of the pressure without upsetting tool levelling, precision V slides, instantaneous overload control which can be adjusted, and an inbuilt operation counter which only records completed welds. These items together with the process timer and trip controls are duplicated on the one console and function independently. An unusual feature is the provision of stabilised metal rectifiers that are said to give 15 years trouble free service.

Performance figures for the larger model are: 17 sq. in solid weld area in 3 sec; 21 sq. in in 5 sec.; $\frac{1}{16}$ in tear seal weld length on double 0·018 pvc, 150 in; or on double 0·004 pvc 90 in. *H.F. Industrial Services Limited, 317-319 High Road, Wood Green, London, N22.*

MOTOR CONTROLLER
Cyclic Switching of Two Circuits



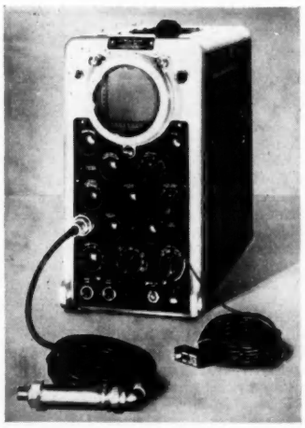
THE control unit type MCU closes alternately two electrical circuits for continuously adjustable periods at continuously adjustable intervals with the overall timing cycle always remaining constant. The overall cycle can be anything between 10 seconds and 30 days.

There are three types: type A in which pressing a push button energises an internal timer which closes alternately two electrical circuits with an adjustable interval between alternate closings to allow the motor to come to a standstill. Pressing the reset button restores the timer in less than half a second (even in the case of the one month units) and also de-energises both motor contactors. Lights show the direction of running and also the presence of voltage supply.

Type B energises alternately two motor contactor coils for continuously adjustable periods at continuously adjustable intervals with the overall timing cycle remaining constant, but the unit does not reset to zero position on power failure. Disconnection of the voltage supply stops the unit and the timing action is continued on restoration of the input voltage. The unit is provided with indicator lights but not with built-in push buttons.

Type C offers the same facilities as type A but not only the individual on and off periods are adjustable, but also the overall timing period, both continuously and independently. All units have a switching capacity of 6A at 250V a.c. The units are supplied as standard in 10 gauge steel enclosures. Watertight or flame-proof enclosures can also be provided. *Electrical Remote Control Limited, Bush Fair, Harlow, Essex.*

PRESSURE MEASUREMENT
Display and Recording



THE Hydraudyne model 1063 is a small portable instrument permitting the display, analysis and measurement of pressure conditions in all hydraulic and pneumatic systems. It provides graphically an accurate means of ascertaining the exact static pressure in a reservoir or conduit and will display variations therefrom of any rate of change from zero.

It consists of an oscillograph unit with a long-persistance tube having a built in amplifier and a time base with delay facilities. A single pressure transducer covers the range from 0 to 8,000lb per sq. in, and a 35 mm camera with motor drive is fitted for recording purposes. When photographing, the instrument is set to produce a single traverse only at any speed in the range provided. The start of the scan can also be delayed so that a record of phenomena occuring subsequent to the initial pressure wave can be made.

A time scale by which calibration of the pressure phenomena may be carried out has been arranged by brightness modulation of the trace producing a series of stationary dots spaced by intervals of 0·2, 0·02, 0·002, and 0·0002 sec. *Cossor Instruments Limited, Highbury Grove, London, N5.*

PIPELINE VALVE
Smooth Bore to Pass Go-Devils

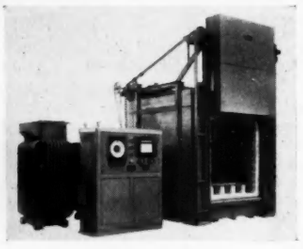
THE new Triangle through conduit pipeline valve in cast carbon steel is designed to meet the need for a valve with a smooth passage to allow the use of " go-devils " but which also has a positive shut-off.

The valves are made in a range of sizes from 6 in to 30 in diameter and for three working pressures namely, 275 lb per sq. in; 720 lb per sq. in; and 1,440 lb per sq. in. The corresponding test pressures are 425 lb per sq. in; 1,100 lb per sq. in; and 2,200 lb per sq. in.

Normally supplied for manual operation, the valves can be converted for motor drive quite simply, as the flange has dimensions standard for actuators. The body and bonnet are made of cast carbon steel and the discs are chromium plated. The seats are 13 per cent chromium steel, Stellite faced and screwed in. Spreader and carrier are carbon or alloy steel with Monel or Stellite facings on the spreader. *Triangle Valve Company Limited, PO Box 38, Lamberhead Green, Wigan, Lancs.*

TREATMENT FURNACE

Up to 1,100° C



With the type of box furnace illustrated, temperatures up to 1,100°C are possible with forced air circulation or with protective atmospheres. The temperature is even throughout the interior.

The model illustrated measures internally 4 ft 6 in by 5ft and is rated at 510 kW. Heavy nickel chromium elements are mounted in the roof and on the sides; heating of the hearth is not necessary as the forced circulation carries the heat under the floor that supports the charge. There are four fans made from Nimonic 75 to give the circulation, and the air guide is made of the same material.

Each fan is mounted on a tubular Nimonic shaft and is supported outside the furnace in two ball bearing plummer blocks. Compressed air passes down an inner Nimonic tube and then back between the tube and the outer walls of the shafts. This gives sufficient cooling to maintain the hot end of the shaft at a temperature below 800° C. The four shafts are belt driven from an 8 h.p. motor, at 1,700 r.p.m. up to 800° C and at 850 r.p.m. for higher values; the changeover is automatic.

The temperature control is by voltage regulation from a potentiometer control. This enables the furnace to be operated at any temperature from ambient to 1,100° C, so that only a portion of the rating is used according to the heating required. The temperature variation across the chamber is negligible at 1,100° C, which value takes about 5 hours to reach from cold. The tolerance on temperature at 750° C is plus or minus 5°. *Hedin Limited, Commerce Estate, South Woodford, London, E18.*

CIRCULATING PUMP

For Central Heating Systems

The Kalorite pump has been designed for use in domestic central heating systems using small bore pipes and forced circulation.

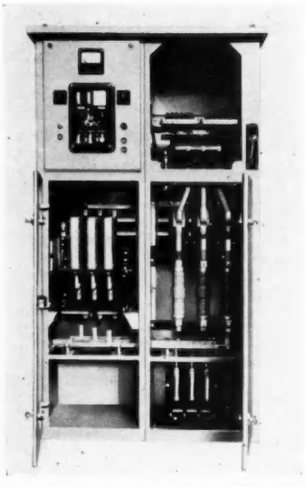
It is therefore cheap, and virtually noiseless, allowing it to run night and day. The power consumption is approximately 45 watts.

The rotor is of the canned type running in a sheath of stainless steel which separates it from the stator and avoids the use of sealing glands, with their consequent risk of leakage and inevitable friction losses. The water being circulated supplies the lubrication for the rotor bearings.

All the internal parts are accessible from one side of the pump so that it can be fitted snugly against a wall. It is normally fitted into the pipe work and does not require any wall fixing. The motors are wound for three phase supply, but the smaller sizes can be run from single phase systems by the use of condensers. To give the necessary starting torque two condensers are used, one of which cuts out automatically when the pump is running while the other maintains the correct phase balance. Sizes are available for circulating from 1 to 160 gallons per minute for heads up to 26 ft. *Harland Engineering Company Limited, 20 Park Street, London, W1.*

STARTER

Direct-on-Line for Motors up to 600 h.p.



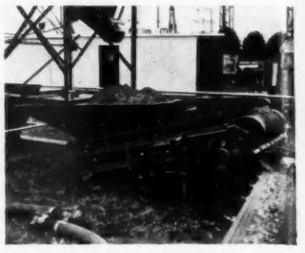
A new Belmos starter is designed for direct-on-line starting of motors of up to 600 h.p. at 3·3 kV. The pillar housing has two forms, one for free standing and the other for use in a switchboard.

The pillar comprises two compartments one of which contains the contactor and the other the current transformers, the fuse links and the control circuit transformers. Above are the instruments and isolator chambers. In switchboard form the main busbars have a continuous rating of 1,000A.

The contactor and magnet assembly is mounted on a withdrawable chassis and the main connections are made by blade and clip contacts. The contactor has a breaking capacity of 1,300A at 0·25 power factor. Up to five auxiliary switches can be operated by the contactor. The isolator is interlocked, and can be connected for forward-reverse or on-off operation. Up to 12 auxiliary switches can be fitted to it. The contactor operating coil is direct current operated from a germanium rectifier and a line transformer. Sequence interlocking and starting can be provided. *Belmos Company Limited, Bellshill, Lanarkshire.*

AGGREGATE HANDLING

Portable Conveyor System



The Fulflo conveyor feeder has been produced to receive intermittent loads of concrete or aggregate and feed them evenly to a conveyor system.

The hopper on the Fulflo has a capacity of 1¼ cu. yards and receives its supplies from concrete mixers, Readymix vehicles or rear tipping lorries. Below the hopper is a belt 36 in wide and driven by a fan-cooled 2 h.p. motor at speeds up to 100 ft per min.

The flow of the material from the receiving hopper is controlled by an adjustable outlet which enables both capacity and width of stream to be regulated. The 12 in diameter driving and idler drums are of heavy steel construction and a series of 4 in steel idler rollers absorb any impact load on the belt. A counter weight scraper is fitted having a renewable rubber blade.

Mounted on pneumatic tyred wheels, the unit incorporates two adjustable screw jacks to take the load off the tyres when set up for operation. There is an adjustable bar for towing.

Portable remote control stations fitted with wander leads can be supplied to enable an operator to control one Fulflo unit and up to six conveyors from a central position from which he can view both supply and delivery points. The standard unit has a motor for 440 V 3 phase 50 cycle supply with manual, local or remote control. Alternatively a 110V motor can be fitted, with a multi-control arrangement.

"Speedyfeeder" conveyors, which are suitable for use with the Fulflo, are available in lengths of 12, 18 and 24 ft. *Wickham Engineering Company Limited, Dashwood House, Old Broad Street, London, EC2.*

INSULATION TESTER

Self Contained 10 kV Unit

The Hymeg portable self-contained instrument has been designed to test insulation resistances up to 20×10^{12} ohms with an internally generated voltage of 10 kV.

The voltage is supplied from a battery operated transistorised RF EHT generator followed by a step-up transformer and multiplier stack. The indicating unit is a micro ammeter fed from a valve operated battery-driven measuring bridge of the valve voltmeter type.

The EHT test potential is separately controlled, and the instrument can therefore be switched to the standby position and the voltage applied only when actually required. Two outputs of 2 kV and 10 kV respectively are available from a special socket and are indicated on the kV scale of the instrument dial.

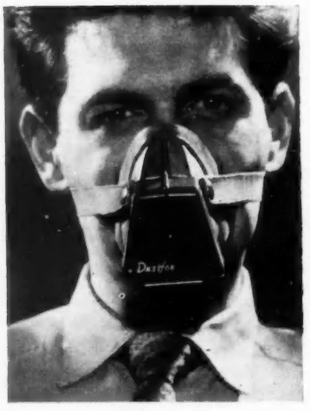
The dial of the indicating instrument is directly calibrated. Apart from the on/off switch the instrument incorporates both zero-setting and the separate EHT controls. The panel has been designed with the conditions imposed by field service in view, and the whole case has been made robust to withstand shocks and rough handling that may be encountered.

High stability and potted components have been used throughout with the aim of obtaining maximum stability during operation.

The batteries used for supplying the power are easily replaceable since they are standard commercial types. The source of generation is such that even the higher test voltage of 10 kV is non lethal, rendering the instrument safe to handle in the field. *Miles Hivolt Limited, Shoreham Airport, Sussex.*

RESPIRATOR

More Comfortable More Effective



The Dustfoe 66 respirator, which carries H.M. Factory Inspectorate Certificates, is an improved model of earlier types.

The face cushion has been given a new contour to give a better fit to most wearers, and more sponge stock has been added to make a better seal on most facial types. Neoprene sponge is used, which is claimed not to harden in use and to be more durable than earlier types. The cushion is easily replaceable.

Larger exhalation valves are fitted, with the result that breathing is easier. They are spring retained to eliminate the variation in resistance which can be disturbing to the wearer.

Static web filters are incorporated in the model 66, and these have been treated with an electrostatically charged resin. It is claimed that this produces a filter of low breathing resistance coupled with maximum filtering efficiency. The filter holder is narrow to eliminate blind spots in the wearer's range of vision. Another feature is that counter gravity flow has been used, the air being drawn upwards into the filter so that the heavier particles tend to gravitate out before reaching the element. Complete with headband the respirator weighs only three ounces. *Mine Safety Appliances Company Limited, Queenslie Industrial Estate, Glasgow, E3.*

NATURAL VENTILATION OF ROAD TUNNELS

For road tunnels carrying traffic in one direction only, the air drag on the vehicles induces a draught which can be sufficient to ventilate the tunnel without installing expensive plant. Experiments have been carried out at the Mechanical Engineering Research Laboratory (now the National Engineering Laboratory) East Kilbride, to find out how the induced draught is related to the size of the tunnel and the traffic density.

Scale models of the proposed Crindau tunnel (on the Newport bypass) and the London Airport tunnel have been tested over a range of traffic speeds and various spacings between the model vehicles. The airflow in the tunnel at London Airport was also measured to ensure that scaling-up from the tests was justified.

It was found that the velocity of induced air flow is directly proportional to vehicle speed for a given spacing and type of traffic. It also increases when the vehicles are closer together. The draught was found to increase as the tunnel length is increased up to a certain length, at which level it becomes constant. A formula has been derived for predicting the induced velocity from factors which include the length and shape of the tunnel and the spacing and shape of the vehicles.

If natural ventilation is to be relied on, the induced draught must be sufficient to keep the concentration of carbon monoxide from the vehicles' exhausts below danger level. The tests have shown that, with a normal continuous flow of traffic in one direction and no adverse wind, it should be safe to rely on natural ventilation in tunnels of medium length, such as the proposed Crindau tunnel which is 1,120 ft long. The decision whether or not to instal forced ventilation must, however, take account of the effect of adverse winds and traffic hold-ups arising from accidents.

Full details of the investigation are given in MERL Fluids Report No. 74, "Investigation of Induced Road-Tunnel Ventilation," by L. H. Butler, available from the Laboratory.

FINDING ROADS TO WITHSTAND TRAFFIC

A major test is under way in the United States to determine how concrete and asphalt roads of known thickness stand up to repeated wear by vehicles of known weight and load. The project is sponsored by the American Association of State Highway Officials and is being supervised by the Highway Research Board of the National Academy of Sciences.

The test highway, located in Illinois, consists of six test loops; altogether there are 836 separate test sections made up from 180 different combinations of surface, base and sub-base thickness. Half the sections have Portland cement concrete surfaces and the remainder asphalt. The test roads vary widely in thickness: rigid (concrete) slabs range from 2½ in to 12 in and the sand-gravel sub-base material under the slab from zero to 9 in. Flexible (asphalt concrete) surfaces vary from 1 in to 6 in thick above crushed stone bases ranging from zero to 9 in and sand-gravel sub-bases of zero to 16 in.

Ten lanes in five of the loops are being subjected to traffic, each lane (approximately 2 to 3 miles in length) carrying vehicles of known types. The sixth loop carries no traffic but is being used for deflection and warping tests and to evaluate the effect of weather on the roads. The traffic consists of 60 trucks driven by US Army men and for two years the trucks will be driven 18 hours a day, six days a week along the 8 mile right of way. (A useful opportunity to observe vehicle behaviour.)

The test vehicles cover a wide range in size and axle loading. Lightest are the trucks with single axle loads of 2,000 lb; the heaviest are tractor-trailer combinations, some with single axle loads of 30,000 lb and others with tandem loads of 48,000 lb.

The cost of the investigation is put at about $22 million, including the $1 million of mechanical and electronic equipment being used to measure the behaviour of the test sections. The site was chosen because both climate and soil are typical of wide areas of the United States and the results are likely to play a large part in the future design of American highways.

ROTODYNE LIFTS BRIDGE SPAN

A bridge span, over 100 ft long, has been carried by a Fairey Rotodyne vertical take-off airliner. It is claimed to be the largest structure ever lifted by air anywhere in the world, though the weight of the bridge has not been disclosed. The flight was part of a demonstration staged for the British Services and the Ministry of Supply. It was the first occasion that the Rotodyne had been seen in a "flying crane" role.

The bridge frame, 10 ft wide by 7 ft high and 103 ft long (exactly twice that of the Rotodyne) was suspended by cables to a central point under the fuselage. It was lifted vertically from the Fairey airfield and transported three miles to the site where it was lowered to span the river at the required spot. To prevent the frame from yawing at high forward speeds, it was fitted with quickly removable wooden fins designed by Fairey.

Another similar task recently performed by helicopter was the positioning of red-light warning beacons on the top of two 1,300 ft peaks of the Tygerberg mountains in South Africa. Each beacon, weighing ¾ ton and made by GEC of England, was flown above ground virtually impassable to land vehicles; moreover, had lorries been used, it would have been necessary to break the beacons down into weights handlable over difficult climbs.

By using the helicopter, hired from the SAAF, the operation was speeded up by weeks. The beacons were flown seven miles to the mountain tops and lowered—despite a 20 knot wind—directly on to 7 ft 6 in square platforms standing 20 ft above the peaks.

Tunnel Driving at Speed

At Agecroft Colliery, North-Western Division, NCB, a new tunnel has been advanced 81¼ yd in five days, working 15 shifts each of eight hours. The tunnel is 15 to 17 ft wide by 13 ft high and driven on a gradient of 1 in 350. The tunnel is supported by 3-piece standard arches set at 3 ft intervals, close boarded and packed solid with rubble. Eight Atlas Copco rock drills on pneumatic pusher legs were used to make 55-60 holes 9 ft deep per round to pull 8 ft 6 in. Eimco Rocker Shovels were used to load away spoil into mine cars.

London's New Tube Receives more Support

The London Travel Committee is lending its support to the proposal to construct the new underground railway in London—the Victoria line to run from Victoria to Walthamstow. The new "tube" would have easy connections with all the other tube lines and give a much needed direct rail connection between Victoria on the Southern Region, the West End, and Kings Cross on the Eastern Region of British Railways. The Ministry of Transport is reported to be again studying the proposal.

Hydroelectric Power on the Danube

A report prepared by the secretariat of the Economic Commission of Europe shows that the potential hydroelectric power available along the River Danube is 31 million MWh; about 2·6 million MWh (8½ per cent) of this has been developed to date. Three other schemes, at Aschach and Korneuburg in Austria and at Wolfsthahl on the Austro-Czechoslovakian border, have been planned in detail. Their combined output would amount to another 2 million MWh.

Vibrations Improve Pile Driving

Faster pile driving—five times faster—results from vibrating piles during hammering, reports from Russia state. In the United States, engineers at the Armour Research Foundation of Illinois Institute of Technology have suggested a research programme to improve pile driving techniques by (1) a device vibrating so as to relieve friction forces along the pile sides and (2) a device that will apply a pulsating vertical load to the pile head phased to reinforce the travelling stress wave in the pile.

Extracting Disused Service Pipes

An extractor for withdrawing disused service pipes and cables has been developed by E. Pass and Company Limited, of Denton, Manchester, to save excavation along the route. Only a small access pit is required at each end. The extractor works hydraulically and is manually operated; a self-compensating three-jaw chuck grips the pipe and applies the pull. Depressing a pressure relief valve returns the ram to the forward position. A replacement pipe can be coupled to the old and drawn into position simultaneously.

Sewage Sludge Handling

New equipment has been designed for mechanically handling sewage sludge by David Brown Construction Equipment Limited, Hanworth Park, Feltham, Middlesex. The basic equipment comprises a David Brown 950 Dual Pivot Overloader tractor and a 3½ ton Weeks tipping trailer with built-up sides. Details are given on a leaflet available from the company.

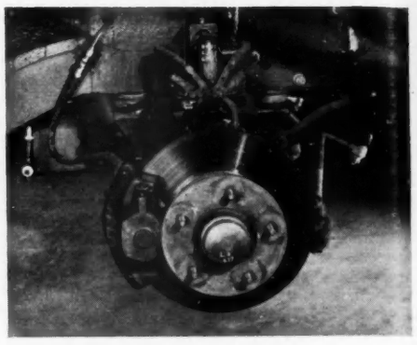
WOLSELEY 6/99

3 Litre Car with Farina Styled Body

By Gordon Wilkins

BMC have quickly followed up the success of their 1½ litre Farina-styled sedans by introducing a new six-seater car with 3 litre six-cylinder engine, five-speed transmission and disc brakes on the front wheels. Known as the Wolseley 6/99, this model too has a body styled by the Italian master; in fact, the extra width of the six-seater body gives better proportions to front and rear aspects of the car and shows off the lines of the massive hard-angled style at their best. With an engine giving 112 b.h.p., a three-speed all-synchromesh gearbox supplemented by BW overdrive on second and third speeds, disc brakes, servo assisted on the front wheels, and luxurious interior finish in leather, walnut and pile carpets, this is one of the most impressive medium-priced models to come from the European industry in recent years. Costing not much more than the old and undistinguished 6/90 it represents remarkable value for money. Borg Warner automatic transmission is offered at extra cost.

A family six-seater with five-speed transmission.



The front wheels are fitted with disc brakes.

The new body is a unit-construction all-steel job of four-door four-window style with double-curved windscreen and full width rear window. The tail fins are not exaggerated but are big enough to enable the driver to see all four corners of the car without stretching his neck. They terminate in grouped stop-tail and turn indicator lamps with red reflectors.

The body is a genuine six-seater with two wide front seats which can be lined up to form a bench seat. For four people, the seating is luxuriously comfortable, with big foam rubber cushions upholstered in leather supporting the legs, and rolled gently under the knees, and high broad backrests. There are armrests on all doors except the driver's and separate armrests at the inner side of each front seat. Front headroom is generous and rear head space is well above the current average. Although the body lines are handsome, this is not a car where passenger comfort has been sacrificed for appearance. The windows wind down completely into the doors and there are pivoted ventilating panes on each door. Heater,demister and fresh air circulator are available as required in export markets. Road/fog lamps are recessed into the front alongside the radiator grille and an automatic reversing lamp is built into the hand grip on the trunk lid. There are two sun visors, lockable glove box, electric clock, screen washer, cigarette lighter and four ashtrays (two in the front doors and two in the backs of the front seats). There is a parcel shelf in front (interrupted by the casing for the heater and ventilation system, which is housed partly within the body) and a full width parcel shelf behind the rear seat.

Although the smaller models have a lever under the wheel to work the turn indicators, the 6/99 has a small switch on the centre of the wheel which is a retrograde step, but there is an unusual feature, as the little switch trigger is itself illuminated when they are showing. The switch is of course self cancelling.

The luggage trunk is vast—18 cu. ft and is quite unobstructed as the spare wheel is carried in a separate cradle under the floor.

The engine is basically the BMC C-type six, expanded by bigger bores as on the Austin Healey 3000 already announced, to a swept volume of 2,912 c.c. (177·7 cu. in). Compression ratio is 8·23 to 1 (7·2 for markets where fuel grade is low) and gross brake horsepower is 112 at 4,750 r.p.m. (or 109 b.h.p. on the lower compression ratio).

Crankshaft and valve gear are largely unchanged. There are two SU carburetters, but unlike the Austin Healey, this engine has them bolted to a manifold which forms an integral part of the cylinder head and is not a separate unit. A light alloy air trunk connects the carburettors to a dustbin-sized oil-bath air filter which is probably the largest so far seen on a British car. A gear-type oil pump has replaced the former rotor type.

The clutch is now of 10 in diameter and the gearbox is entirely new. It has Porsche servo ring synchromesh for all three speeds, and is controlled by a steering column lever. Behind it is the Borg Warner overdrive, which operates on second and top gears.

Suspension is conventional, with wishbones, coil springs and piston type dampers on a rubber-insulated cross-member; and a rigid axle with half elliptic springs and piston type dampers at the rear. Anti-roll bars are used at front and rear.

The braking system is a new design by Lockheed, with vacuum servo assistance on the suspended vacuum principle. The front disc brakes have a diameter of 10 in. They have fixed iron calipers with operating pistons and segment-shaped pads on each side of the disc. The front brakes provide approximately 60 per cent of the braking effort. Drum brakes are used at the rear with drums 10 in diameter and there is a valve in the hydraulic circuit which limits the total pressure that can be applied to the rear brakes. Behind the seat backrest are two SU electric pumps of the latest type. Normally both are in use, but in the event of trouble with either one, the other is capable of keeping the car running at up to two-thirds throttle.

MGA SPORTS CAR

Larger Engine and Disc Front Brakes

The MGA Sports car gains extra performance and increased stopping power at no extra cost in its latest version, the MGA 1600. Engine size is increased to 1,598 cc by enlarging the bores to 75·39 mm making it the same size as the twin-cam unit. Maximum net power goes up to 79·5 b.h.p. at 5,600 r.p.m. and maximum torque to 87 lb ft at 3,800 r.p.m. An increase of 6½ per cent in swept volume has thus produced a rise of 10 per cent in power and 12½ per cent in maximum torque. Lockheed disc brakes of 11 in diameter are fitted at the front and improved drum brakes of 10 in diameter at the rear.

The styling of the new MGA 1600 is much the same as its predecessor. The main distinguishing feature is a new chromium "1600" badge on the wings.

Externally, there is little to distinguish the more powerful MGA beyond a 1600 badge behind the air exit grilles on the front wings, new side lamps, amber turn indicators combined in one unit at the front and more prominent plinths carrying separate tail and turn lamps. On the open two-seater there are more convenient rigid side screens with sliding plastics windows. A detachable hard top is available and the MGA 1600 is offered additionally as a fixed head coupé with glass side windows.

The larger cylinder bores have been obtained by siamesing the first and second pairs of cylinders, eliminating water spaces between them as on the twin-cam. Despite the extra cylinder volume, compression ratio has been held at 8·3 to 1 and valve sizes are unchanged Big ends have white metal bearings with plating of lead-indium; mains are white metal. Carburettors are two SU of 1½ in. There is no change in gearbox or axle ratios. Normal final drive is 4·3 to 1; 4·55 is available to order. Speeds in the gears at 6,000 r.p.m. are 1st, 27 m.p.h., 2nd 44 m.p.h., 3rd 71 m.p.h.

Optional items at extra cost include the special competition seats which are already ordered on 50 per cent of all twin-cam models and nearly 70 per cent of all coupés. Other options; an effective heater and demister, twin horns, windshield washer, cold air ventilation, competition windshield, anti-roll bar for driver protection, headlamp flasher switch and relay, cockpit cover, adjustable telescopic steering column, centre lock wire wheels.

Technical Details.—Engine, 4 cyl. o.h.v. push-rod 75·39 × 88·9 mm (2·968 × 3·5 in), 1,588 c.c. (96·9 cu. in). 87 lb-ft torque at 3,800 r.p.m. Borg and Beck clutch, 24·3 sq. in friction area, hydraulically operated. Four speed gearbox with synchromesh on top three. Hypoid final drive. Overall ratios 15·652, 9·520, 5·908, 4·3 to 1. Reverse 20·468 to 1. Gearbox ratios 3·64, 2·214, 1·374, 1 to 1. Reverse 4·76 to 1. Alternative axle ratio 4·55 to 1. Dimensions: Wheelbase 94 in. Track front 47½ in, rear 48¾ in. Length 156 in, width 58 in, height 50 in. Ground clearance 6 in. Turning circle 30 ft 6 in Kerb weight 2,018 lb (two seater). Tyres 5·60—15 in. Fuel tank 10 Imp. gal.

SPECIAL RECORD OF ENGINEERING NEWS
FROM 19 JUNE TO 7 AUGUST *Arranged by Departments*

News that would have been reported in ENGINEERING, *but for the printing stoppage, is reviewed by departments in the following summary. In the case of Weekly Survey the dates indicate the issue in which the notes would have appeared.*

Weekly Survey

26 June

1958 World Recession Measured

According to the United Nations *Year Book of National Accounts Statistics 1958*, global output fell slightly in 1958 mainly owing to a 3 per cent drop in the output of the United States and Canada. Between 1951 and 1957 the gross national product of Western Europe (at constant prices) went up by nearly 5 per cent per annum, the largest rate of increase being Western Germany with an increase of 7·5 per cent per annum.

United States Turbine Imports Ruling

The Office of Civil and Defense Mobilisation has decided not to recommend restrictions on imports of heavy electrical machinery into the United States. The decision is particularly relevant for exporters of turbines from this country, although the agency has still to find on a further petition affecting steam turbines and generators. The subject is not, however, closed since the OCDM decision can still be reversed by Congress where pressure from United States electrical engineering manufacturers and trade unions is likely to be severe.

Russians on Aswan Dam Costs

Soviet engineers in Egypt have claimed that changes which they recommend will cut costs by 20 per cent in constructing the Aswan High Dam. Modifications include substitution of an open channel for the seven diversion tunnels of the original plan. Both of these are considered technically sound but the Russians claim that their solution is more suitable to conditions in Egypt where there are large reserves of manpower.

Higher Line-Definition Coming ?

The old controversy about 425-line definition and 625-line definition for television in this country has been revived. The Government is considering the report of a technical subcommittee of the Television Advisory Committee which is thought to recommend changing over to 625-line definition. It is likely that both systems would have to be operated in parallel for a number of years.

Fifth FBI Inquiry

An improvement in business sentiment is shown in the fifth inquiry by the Federation of British Industries compared with four months previously. Of the replies 59 per cent were more optimistic and only 4 per cent less so. More reported an increase in home and export business than a decrease.

Warning on C Licences

Speaking recently to the London branch of the National Union of Manufacturers, Sir Brian Robertson, the chairman of the British Transport Commission, said that if the growth in C licences continues at its present rate it will virtually eliminate public transport, starting with public road transport. He then added enigmatically that the railways would get the business sooner or later—a lot of it if not all of it.

Britain Develops Borax

British capital is still the main source of development in United States borax. This investment is represented by 3·1 million common shares in the United States Borax and Chemical Corporation. This is a 75 per cent controlling interest. British initiative has pioneered new techniques of open-pit borate mining and refining. The industry is now coming out of the recession after a period of heavy investment and dividend payments are still taking second place to capital equipment.

3 July

Recession Hits the BTC

The total deficit for 1958 of the British Transport Commission was £88·98 million, almost £25 million more than in 1957. Gross receipts of British Railways dropped over 6 per cent, mainly due to lower freight traffic. Working expenses were reduced by £9 million, despite wage and price increases of £13 million. The main cause of the drop in income was the recession, especially in the coal and steel industries.

X15 Rocket Aircraft Takes Off

The experimental X15 rocket aircraft which has been designed to fly at speeds up to 4,000 m.p.h. made its first flight in California in June. It was dropped from 38,000 ft and glided smoothly on to a dry lake bed at a touchdown speed of 200 m.p.h. This project, sponsored by the National Aeronautical and Space Administration, involves the production of three prototypes over the five year period 1956 to 1961 at a cost of about $123 million.

Research Aid for Computers

Further development work on advanced computers is to be helped by the National Research Development Corporation. Assistance is to be given to two computer manufacturers, Ferranti Limited and EMI Electronics Limited. Collaboration between the NRDC and EMI has already produced the advanced EMIDEC 2400, units of which are already in production. The aim of the colaboration is to produce two different advanced computers in the United Kingdom which will be competitive in world markets.

10 July

Oil Recovers from Suez

Oil production last year resumed its upward trend which was interrupted by the Suez crisis. According to a survey by the British Petroleum Company Limited proven reserves last year increased more rapidly than production and much of this increase occurred in the Sahara. Refining capacity increased with demand but the world tanker fleet increased by 6 million tons deadweight, by more than 12 per cent, while the volume of oil moved in international trade increased by only 6 per cent.

Anglo-American Supersonic Airliner ?

Collaboration between this country and the United States in the development of supersonic civil airliners was urged by Mr. Peter Masefield, when delivering the inaugural Wakefield Memorial Lecture to the College of Aeronautical and Automobile Engineering. He said that decisions taken within the next few months will influence the whole pattern of the British contribution to both aeronautics and astronautics in the years to come. Mr. Masefield is managing director of Bristol Aircraft Limited and president of the Royal Aeronautical Society.

New Agricultural Aviation Group

The Royal Aeronautical Society has recently formed an agricultural aviation group. The aims of the group are to further the use of aircraft in agriculture, forestry, pest control, fertilising and seeding. The group hopes to take part in the International Agricultural Aviation Conference to be held at Cranfield in September, 1959.

Mechanical Engineering in Switzerland

A paper was read before the Institution of Mechanical Engineers at the end of June by Mr. George Sulzer, chairman of Sulzer Brothers Limited, on " Mechanical Engineering in Switzerland." The Swiss mechanical engineering industry came into existence to provide equipment for the textile industry when the continental blockage in the Napoleonic Wars cut imports from the United Kingdom. In 1958 the industry employed 169,000 workers out of a total of 624,000 factory employees in the country, or 27 per cent. In 1957 the average number of employees in mechanical engineering works in Switzerland was 89. This low figure is given by the large number of small concerns but there were 68 works in that year with over 500 employees.

Higher World Production

In 1959, the *World Economic Survey 1958* (issued by the United Nations—HMSO, price 22*s* 6*d*) predicts that the level of activity in industrial countries will exceed the 1958 level. The present upturn will probably continue, but the rate of expansion is not expected to be as big as in the last big world upspring of economic activity in 1955. The survey points out that the United States among other countries, is becoming increasingly concerned about its balance of payment problems in relation to growth policies. The survey warns that this preoccupation should not extend to a tendency towards gold hoarding

Credit for Exports

The Federation of British Industries addressed a memorandum on credit facilities to the Chancellor of the Exchequer and the President of the Board of Trade towards the end of June. The main proposal in the note was that existing credit facilities for British exporters of heavy capital equipment should be supplemented by long-term loans to the foreign customer—not to the British manufacturer. Such loans might run for a term of 15 years. The memorandum went on to say that a five year repayment period which is the maximum available through ECGD, is not realistic for large capital projects where the buyer has to meet the cost of these investments from revenue.

17 July

Modifications to the DH121

The present design of the de Havilland 121 medium-range jet airliner has been scrapped. So far £800,000 has been spent on the project. BEA has said that it requires a plane to carry 70 or 80 passengers not 120 as in the original specification. The plan seems to be to reduce the original DH121 to a size suitable for the smaller payload. This involves not only re-

ducing the fuselage but also persuading Rolls-Royce to develop a smaller engine for a new design or going to another aero-engine manufacturer.

24 July

Lockheed Foresee

The Lockheed Aircraft Corporation has produced a scheme to deal with the transport crisis likely to arise by the end of this century when high-speed airliners (travelling at speeds of say 2,000 m.p.h.) go into service between cities and countries whose air space is congested. This includes the use of "Aircommuters" carrying 40 to 50 passengers at over 300 m.p.h., "Limocopters" which would be luxury helicopters and "Airtrains" which would use monorails to carry 200 or more passengers at 60 to 75 m.p.h. in areas of dense population. Lockheed is building its first "Airtrain" at Seattle for an exhibition to be held there in 1961.

Spain in OEEC

Spain has become the eighteenth member of the OEEC. This will mean that the Spanish Government has to revise its economic policies, especially concerning quotas. These will have to be enlarged progressively under the OEEC Code of Liberalisation and a target of 50 per cent by the end of July has been announced. A new rate of exchange of 60 pesetas for one dollar has been fixed. The OEEC countries have promised to help the new member by granting a credit of $100 million on the European Monetary Agreement Fund. The International Monetary Fund has made a loan of $75 million and the United States Government one for $200 million.

31 July

World Bank Loan to India

The International Bank has granted a loan of $50 million to India to assist the Indian railways in their development programme under the Second Five Year Plan. The total expenditure on the railways under the plan comes to $2,355 million and of this $809 million is required in foreign exchange. After allowing for the loan from the World Bank, the amount of foreign exchange still to be found is $230 million.

Power Equipment Battle in the US Continues

The English Electric Company Limited has filed a lawsuit through its agent in Washington, along with two local taxpayers, against the Commissioners controlling the award for the Wanapum Dam contract on the Columbia River. There are reports that the US contractors who have been awarded the project propose using imported equipment in order to meet the low price which they have tendered. Meanwhile the General Electric Company of the US has announced that it has secured an order for a large steam turbine generator against English and Swiss competition. Its price has been cut by 15 per cent in order to secure the project.

7 August

UK Shipyards Feel the Pinch

Cancellations and postponements are beginning to cause awkward gaps in shipyard schedules. In the second quarter of this year, according to figures published in the third week of July by Lloyd's Register of Shipping new building started was less than half the total tonnage launched during the same period. The number of new orders was negligible at 44,000 gross tons. Overall there is enough work for the industry for between two and three years, but the incidence of that work is exceedingly uneven. According to Sir Nicholas Cayzer, president of the UK Chamber of Shipping, some £8 million tons of shipping are laid up throughout the world for lack of freight.

No Change in Road Policy

The criticisms of the Government's road development programme made by the Select Committee on Estimates have been answered by the Ministry of Transport. He has said that despite the criticisms (the committee's comments were by no means all critical) the Government will press on with its road programme. The projected expenditure on new construction for 1959-60 of £55 million will rise to about £65 million in the next fiscal year. Part of the current high rate of development is due to the energy of the Government department concerned and the local authorities which are cooperating, partly to the excellent road-making weather in the spring and early summer of this year.

Unlucky 13?

The number of mergers of British aircraft and aero-engine manufacturing companies during the past 18 months has reached thirteen. The latest one has been the merger between Westland and Saunders-Roe. In 1949 there were 33 aircraft manufacturers and 12 makers of aero-engines. Today these figures are 24 and 6 respectively and 17 of them are in groups of two or more. Concentration within the industry is taking the form not only of formal mergers, but also of consortia created for specific projects. The two best known are the Aircraft Manufacturing Company (a consortium consisting of de Havilland, Fairey and Hunting), and the one between English Electric and Vickers, these last two having come together on the TSR 2 supersonic bomber with Bristol Siddeley providing the engine.

Shrinking Railways

The review of the railway modernisation plan which was published by the British Transport Commission on July 24 calls for a speeding up in the programme of cutting out uneconomic lines and in the modernisation scheme itself. In seeking a more compact railway system the Commission wants investment to go up on the railways from £178 million in 1959 to £210 million in 1962 and 1963. There will be changes in the schemes priorities but not in the basic pattern. Hopes for a smaller system being more intensively but more economically used depend on the system carrying a larger volume of passenger traffic.

Companies in the News

Military Adviser for Shorts

Brigadier G. L. Fitzgerald has been appointed as military adviser to Short Brothers and Harland Limited, and will be concerned primarily with the SC.5 Britannic project. Brigadier Fitzgerald has been closely associated with the recent development of military equipment and weapons for the Army and has considerable experience of the organisation and planning involved in this field.

Motores Perkins SA

Considerable expansion of the activities of F. Perkins Limited, following their acquisition by Massey-Ferguson, is taking place, though several developments had been decided before the takeover. A new company, Motores Perkins SA, has been formed in Brazil to manufacture the Six B340 diesel engine for 5 to 8 ton trucks made locally. Production is scheduled to start during the second half of 1960 and to reach 20,000 engines a year during 1962.

Fairey to Make Plastics Machines

The manufacture and marketing of Dykehouse preplasticising units and self-contained injection moulding conversion units for compression presses has been started by Fairey Engineering Limited at their Heaton Chapel, Stockport, factory. The preplasticising units will double the capacity of existing injection moulding machines.

Advances in Telecommunications

"Research" is one of the main items in the annual statement by the chairman of Automatic Telephone and Electric Company, Sir Thomas Eades. The company's expenditure on research (£500,000 during 1958) he called "our insurance for the future prospects of the company." Most of the research work has been on the development of a fully electronic telephone exchange (Highgate Wood), coaxial cables and transistorised repeaters.

Standard in Italy

Decisions to set up a factory in Italy and a car assembly plant in Kenya were announced recently by Standard Motors. TR 3 sports cars will be made in Naples, in the initial stages from chassis components exported from Coventry and bodies built by Vignale. Eventually the complete car will be made in Italy.

Automation's Progress

The chairman of Elliott-Automation Limited, Mr. Rudolph E. F. de Trafford, suggested in his annual statement that the absence of adequate incentives to reequipment has retarded the large-scale adoption of automatic techniques in this country, and welcomed the reintroduction of the investment allowance. Elliott have continued to expand during 1958 and concluded several new agreements to make new types of American instruments and components under licence. Trading profits for the year exceed £1 million for the first time.

Metal Industries Invest in France

A French company making hydraulic accumulators, servomechanisms, shock absorbers and allied equipment, has been purchased by Metal Industries Limited for about £135,000. The company, Olaer France Société Anonyme of Paris, located at Bois-Colombes, employ about 100 people. Their president, M. Jean Mercier, is the inventor of the Greet-Mercier accumulator made under licence by Fawcett Preston and Company, a subsidiary of Metal Industries.

New Division for Martin

The "broad scope and magnitude" of the operational Titan weapon system has led the Martin Company of Baltimore, USA, to create a new division which will have equal status with the other seven divisions of the company. The Activation Division, as it has been named, will operate as "integrating contractor for the operational Titan weapon system in the field, under the direction of the Air Force Ballistic Missile Division."

Acrow's Purchase

A formal offer to the shareholders of Hardwick Industries Limited has been made by Acrow (Engineers) Limited. Hardwick's are a holding company whose six subsidiaries operate in engineering, reinforced concrete and textiles. The group employ 2,000 people. Acrow's announcement state that "Hardwick's labour force redeployed could make a useful contribution to Acrow's need for more factory space and labour."

Fertilisers in Eire

A major fertiliser factory, costing £2 million, is being built at Cork. This is the new works of W. and H. M. Goulding. Simon-Carves have been appointed as main contractors for the design and development of the final stage. The value of this contract, for a sulphur-burning contact-type acid plant to produce 70,000 tons a year of 100 per cent sulphuric acid, plants to use the acid in the production of 200,000 tons a year

of superphosphates, and the associated handling and storage equipment, exceeds £1 million. The Marina works, as it is known, will be one of the most modern and economic fertiliser factories in the world.

New Lancia Factory

A new Lancia factory is to be built at Chivasso, near Turin. It will have 800,000 sq. metres of floor space.

Franco-Scots Welding

The British firm Solar Industries of Glasgow is forming a subsidiary with Languepin, the French electric welding company, for the sale and manufacture in Britain of welding and spark tooling machines. It will be called Solar Weld Languepin.

Burmeister and Wain in Spain

A high level of shipbuilding activity is taking place in Spanish shipyards. According to Empresa Nacional Elcano de la Marina Mercante, the yards have orders for 259 ships, 253 of which will be equipped with diesel engines. Some 41 per cent of the total will be fitted with Burmeister and Wain engines, totalling 232,316 b.h.p., built by the company's Spanish licensees.

Guide to Exporters

Firms without experience in overseas trading will find *A Simple Guide to Prospective Exporters*, published by the Gauge and Tool Makers' Association most helpful in the commencement and development of an export business. The booklet, which treats such subjects as representation, appointment of agents, documentation, insurance, may be obtained free of charge from the association.

Massey-Ferguson's Massive Performance

The Massey-Ferguson group have succeeded in increasing their world-wide sales by 12 per cent, to £234 million, during the first half of 1959. These results do not include the operations of F. Perkins Limited. Sales in North America increased by 42 per cent and those in western Europe were well maintained at the 1958 level. The outlook for the current half year is thought to be good.

Computer Entente

A new company has been set up in this country under the name De La Rue Bull Machines Limited in which the De La Rue Company of London and the Compagnie des Machines Bull of Paris each hold 50 per cent. The new company will market in the UK and British Commonwealth the full range of business machines and electronic computers manufactured by Machines Bull in France. The latter's founder, was a Norwegian engineer.

Cubitts Prosper

Lord Ashcombe, chairman of Holland & Hannen and Cubitts, reported at the annual general meeting " a greater total profit than ever before " amounting to £831,000, nearly £50,000 more than the previous year. Cubitts have won a place since the war among the world's major contractors with a highly successful civil engineering division and are confident of maintaining their position.

Davy-United Reorganisation

A new organisation has been adopted by the board of Davy and United in order to achieve a greater measure of decentralisation. A holding company has been formed under the name of Davy-United Limited, with two new subsidiaries, Davy and United Engineering Company, to deal with the heavy engineering products of the group, and Davy and United Instruments Limited, to deal with the instruments division. Davy and United Roll Foundry Limited already existed as makers of rolls and steel castings.

The Human Element

Shift Differentials in the US

The United States Department of Labour's " Bureau of Labour Statistics " has made a review of shift differential payments. Over 90 per cent of agreements referring to evening work provide for a pay differential. These have been increasing rapidly and there is a great deal of difference in types and amounts of payment.

Photography in Human Relations

Photography has an important role to play in human relations in industry according to Mr. Walter Nurnberg speaking to the London region of the British Association of Industrial Editors recently. He thought that photography could help restore the dignity of the worker in relation to his materials, the machine he operated and the end product.

The Medical Inspector's Job

The job of the inspectorate is to identify medical problems in the factory and not to undertake research to solve them is the finding of a White Paper called *Duties, Organisation and Staffing of the Medical Branch of the Factory Inspectorate*. It was published in June as Cmnd 736 by the Stationery Office at 9*d* net.

Scotland's Strength in Technical Training

Scotland's strength is in its training of technologists, according to Lord Forbes, Minister of State for Scotland, speaking recently in Aberdeen. It accounts for one-fifth of the United Kingdom total. The weakness of the Scottish system is the day-release education at the lower levels. The aim is to have 17 new technical colleges in operation in the early 1960's.

Holier than Thou?

The incidence of accidents among West German steel workers is three times as great as in this country but both are worse than the record in the United States. Such are the findings of a steel works magazine in the Rhur. The Americans make 15 times as much steel as the British before there is an accident and 46 times more than the Germans. The figures could be misleading unless the definition of an accident is standard—and the drill for reporting it.

National Dock Labour Board Films

The welfare department of the National Dock Labour Board, 22-26 Albert Embankment, SE11, has published a catalogue of films available free for showing to groups of registered dock workers. The industrial subjects include such items as cargoes and mechanical handling; welfare subjects include safety and sport.

Commonwealth Education

A booklet issued by the Central Office of Information called " Commonwealth Education " brings together the facts on education in the Commonwealth with special reference to the British contribution. There is a useful section on technical education and vocational training. In 1958 there were 6,600 Commonwealth students in United Kingdom technical colleges—1,400 from Nigeria and 1,100 from India.

ICI Chairman Retires

The third Scot to head Imperial Chemical Industries, Sir Alexander Fleck, has retired. He climbed the ladder from the bottom, having begun as a " lab " boy at Glasgow University. He graduated at 22 and gained his doctorate for his work on radiological research on cancer. Dr. Fleck joined ICI's main board in 1944 and became chairman in 1953. Two years later he was elected a Fellow of the Royal Society. Mr. S. P. Chambers, an economist who has been ICI's finance director since 1948, is the new chairman.

Britain Beats the Bulge

One of the facts which appears in the annual Ministry of Education report *Education in 1958* published by HM Stationery Office price 12*s*, is that this country alone among the major countries of Western Europe has found places in school for the larger child population since the war, without resorting to such expedients as part-time schooling.

Unemployment at 1·9 per cent

A steep drop in unemployment was recorded in the middle of June. It dropped by 67,000 to 413,000—the lowest figure since July 1958 and the sharpest decline over a month since the fuel crisis of 1947.

Less Fire Damage

A growth in the general interest in fire protection is demonstrated in the latest annual report of the Fire Protection Association entitled *Fire Prevention 1958*. Estimates of annual fire damage show a drop for the third successive year, from £25·8 million in 1957 to £24·1 million. In 1955 the figure was £27·6 million. In the words of the association's chairman, Mr. A. F. O'Shea, " a great encouragement to all those responsible for maintaining a high standard of fire protection."

New College of Advanced Technology

The Bristol College of Technology will be designated as a College of Advanced Technology as from September, 1960. It will be the ninth so classified. Among the conditions which have to be met before a college can be recognised as a CAT is a specified volume of advanced full-time and sandwich course work, and the separation of this from the lower level work. Sir Edward Boyle, who made the announcement, said that the output of advanced students from technical colleges was increasing according to schedule (from 9,500 in 1955 to about 17,000 in the later 1960s); at present it is at the rate of 11,500 a year.

4,000 More Teachers by 1964

A further 4,000 places in teacher training colleges are to be made available by the Government by 1964. This should bring the total places available to 40,000. This announcement was made by the Minister of Education to the Association of Education Committees at Cardiff early in July.

Calculating Labour Turnover

Labour turnover, like productivity, is apt to mean all things to all men. Methods of calculating it are set out in a new pamphlet called *The Cost of Labour Turnover*, published by the British Institute of Management, price 17*s* 6*d*. The booklet is based to a large extent on case studies and an exposition of alternative formulae.

Apprentices and Tax Relief

Speaking at Newcastle towards the end of July, Sir Godfrey Ince, now president of the British Association for Commercial and Industrial Education, made a plea for tax reliefs to firms employing training apprentices.

Arc to Arch

The publicity achieved by the Arc-to-Arch race at the Bleriot half-century celebrations must have far exceeded the hopes of its sponsors. To do the trip in 40 minutes 44 seconds took all the paraphernalia of the jet age but its appeal was in tradition—the harnessing of modern machines to make the channel crossing, the romance of the Paris-London route—not forgetting Passepartout.

Catalysts for Engine Fumes

Considerable work has been carried out by the Warren Spring Laboratory, Greenwich, on methods and apparatus for reducing atmospheric pollution from petrol engines. Mr. Harmar Nicholls, Parliamentary Secretary to the Ministry of Works, told the House that the laboratory had now begun experimental work on the use of catalytic afterburners for the treatment of exhaust fumes from diesel-engined motor vehicles. He was asked by Mr. Gerald Nabarro (Conservative), who had put forward a number of questions on this subject, about tests into the efficacy of an American catalyst in decontaminating and decolorising asphyxiating and noxious fumes. Mr. Nicholls said that it was not until 25 June that the Department of Scientific and Industrial Research knew that this device was available and that as soon as the department was satisfied that there was a device which was worthy of further investigation, it would take steps to obtain a specimen. In the meantime, the department was trying to obtain the technical details.

Pollution of Town Air

Data collected by the Warren Spring Laboratory, said Mr. Harmar Nicholls, showed no indication that the amount of smoke in the air of towns had increased in recent years; in fact, in many towns it had decreased and this was especially so since the passing of the Clean Air Act, 1956. Continuous observations, he told Mr. Nabarro, had not been made on the other pollutants in the air which originated partly from motor vehicle exhausts. There were no indications from the observations that had been made that pollutants from the exhaust gases of motor vehicles accumulated in times of smog more readily than did those from other sources. Referring to a comment by Mr. Nabarro about the appalling pall of obnoxious fumes from the exhausts of vehicles in urban and built-up areas, Mr. Nicholls said that the DSIR had made the public aware of the danger which flowed from the existing situation. The department had also informed the public about all the devices which it had been able to examine. If filters were kept clean and vehicles were well maintained it was possible to reduce some of the nuisance from this source.

Engineering Workers Find New Jobs

Employment difficulties among engineering workers in the Poole-Bournemouth-Christchurch area were referred to by Mr. John Eden (Conservative). In this connection, Mr. Iain Macleod, the Minister of Labour, said that notified redundancies of all kinds of workers from establishments in the area engaged in engineering and the manufacture of aircraft and metal goods totalled about 1,550, of whom about a thousand were discharged by aircraft firms and some 430 by the Royal Ordnance Factory, Poole. Only 102 of those affected were at present registered as unemployed. It was not known how many persons had found alternative employment outside the area.

Government Research Priorities

Information was asked for by Mr. Austen Albu (Labour) regarding the progress being made by the committee set up by the Lord President of the Council to investigate the techniques of management and control of Government-financed scientific research and development. He also wanted an assurance that the committee's terms of reference were broad enough, in view of the appalling problems that faced this country in its efforts to keep up with the United States in such matters as aircraft development and research, nuclear research and space research. Mr. Harmar Nicholls replied that the committee's work had been delayed by the untimely death of its chairman, Sir Claude Gibb, K.B.E., M.I.Mech.E. However, another member of the committee, Sir Solly Zuckerman, F.R.S., had been appointed chairman and Sir George Edwards, F.R.Ae.S., had been made a member. The terms of reference were very wide indeed and covered all the Government's research, both civil and defence. The committee's task was both formidable and complex, and its report would necessarily take some time.

Vacuum Brakes for Goods Wagons

A plea was made by Sir William Robson-Brown (Conservative) that goods traffic should be speeded up by the fitting of vacuum brakes to goods wagons. Mr. Harold Watkinson, the Minister of Transport and Civil Aviation, said that, according to information from the British Transport Commission, the proportion of freight train mileage run by trains fitted with vacuum brakes had now risen to 36 per cent. By the middle of 1960, virtually all merchandise wagons would have been fitted with these brakes. Further progress in fitting mineral wagons depended on the provision of an improved form of coupling satisfactory to both industry and the railways. Experiments were now being carried out with various types of coupling.

New Government Inquiry into Engineering

The intention of the machine tool industry to discontinue the collection of monthly figures of new orders was commented on by Mr. Harold Wilson (Labour). In reply, Sir David Eccles, President of the Board of Trade, said that a new comprehensive statistical inquiry was being conducted by the Board of Trade over a very wide range of engineering industries, including machine-tool production. As a part of this inquiry, monthly figures were now obtained and published of orders on hand and of production. These statistics formed a substantial addition to the economic information available to the Government and the public.

British Part in Space Research

As the result of a visit by British experts to the United States, it is proposed that British scientists shall prepare instruments for satellites to be placed in orbit by the use of the "Scout" vehicle, which the United States National Aeronautics and Space Administration is developing for use in connection with civil scientific research. Mr. Aubrey Jones, the Minister of Supply, told Mr. David Price (Conservative) that the Government had approved these proposals, subject to the conclusion of formal arrangements.

Air Traffic Control Board

It has been decided to set up an Air Traffic Control Board under an independent chairman, with wide terms of reference, including responsibility for formulating air traffic control policy for the United Kingdom. Mr. Harold Watkinson told Mr. Paul Williams (Independent Conservative) that the board will coordinate the work of all authorities in the United Kingdom concerned with air traffic control matters. The board would consist of senior representatives of the Ministry of Transport and Civil Aviation, the Air Ministry, the Admiralty, and the Ministry of Supply, and would be assisted by an Air Traffic Control Executive.

Safety of Life at Sea Conference

Mr. John Hay, Joint Parliamentary Secretary to the Ministry of Transport, told Mr. Hector Hughes (Labour) that the Merchant Shipping (Life-Saving Appliances) Rules, 1958, required the carriage of inflatable life rafts in all fishing vessels over 50 ft in length and in all cargo ships on coasting and home-trade voyages. The number and capacity varied with the size and class of ship. The International Convention for the Safety of Life at Sea required lifeboats to be provided for all on board on each side of a cargo boat. The desirability of replacing a proportion of those boats by inflatable life rafts in cargo ships on long international voyages would be discussed at a conference to be held in London in May, 1960, to revise the convention. Meanwhile, owners of such ships had been recommended to carry life rafts in addition to boats. Inflatable rafts were not considered suitable for oil tankers on long voyages or for whale factory ships, owing to the risk of fire.

More Liquid Methane Arrives

A third experimental cargo of liquid methane gas, with a coal equivalent of around 5,000 tons, recently arrived in Britain, according to information supplied by Mr. Reginald Maudling, the Paymaster-General. He told Mr. S. S. Awbery (Labour) that when the time came to review the results of the experiment, consideration would be given to the desirability of utilising this country's own natural resources and the need for reducing coal stocks.

Nuclear Power Station for Scotland

Mr. Niall Macpherson, Joint Under-Secretary for Scotland, told Lady Tweedsmuir (Conservative) that the North of Scotland Hydro-Electric Board had no immediate need for a nuclear power station and the board had not yet reached the stage of deciding whether they would require one in later years. They had, however, been examining various possible sites, including one at Crimond.

Exhibitions of Building Plant

The series of building plant exhibitions organised by the Ministry of Works, said Mr. Harmar Nicholls, had achieved their object of stimulating the use of mechanical plant, by showing the plant actually at work. The Ministry believed, he told Mr. John Barter (Conservative), that industry itself should now be responsible for any further development of the idea and did not contemplate organising any more of these exhibitions.

Paper Making and the Outer Seven

The British paper-making industry should be able to adjust itself to the new conditions arising from the formation of the Outer Seven, during the ten-year transitional period of mutual tariff reductions, according to Sir David Eccles. He told Mr. E. Thornton (Labour) that this would be especially so if the European Free Trade Association were followed by the establishment of a wider Free Trade Area.

New Graving Dock at Greenock

An application has been made to the Government by Inchgreen Development Company Limited for financial assistance in the construction of a new graving dock at Greenock. In this connection, Mr. F. J. Erroll, the Economic Secretary to the Treasury, told Dr. Dickson Mabon (Labour/Cooperative) that, at a meeting on 9 July with the promoters of the dock, the Prime Minister had offered a substantial measure of Government assistance for the project. The offer was at present being considered by the interests concerned.

Productivity Targets

Since 1953, Sir David Eccles told Major P. H. B. Wall (Conservative), the monthly bulletin *Target* had been prepared by the Central Office of Information, as a means of drawing attention to examples of the benefits of higher productivity. The Board of Trade and the Ministry of Labour had been responsible for its policy. An offer by the British Productivity Council to take over the publication, as from the beginning of next year, had now been accepted, on the understanding that its character should be broadly the same and that a substantial free circulation should be maintained. Parliament would be asked in due course for an additional grant to the Council to aid publication in the early years of the new arrangement.

Metals and Materials

Fluoride Insulation

Films formed on copper or aluminium by exposing the metals to fluorine or hydrogn fluoride, are said by Bell Telephone Laboratories, New York USA, to be flexible and non-porous. Electrical insulation values are very high—10^{10} to 10^{11} ohms at room temperature for films 1 and 2 microns thick, between probe electrodes $\frac{1}{4}$ in in diameter. The films retain these properties at high temperatures: aluminium fluoride films exhibit resistances of about 7×10^8 ohms up to 500° C and will withstand 450 volts at this temperature.

More British Polyethylene

Monsanto's polyethylene plant at Fawley, near Southampton, is now in production (see ENGINEERING, 1959, vol. 187, p. 24). The factory has cost some £3¼ million to date for an annual output of 10,000 tons a year. In addition to the manufacturing buildings there is a versatile 1/200th scale pilot plant reactor system to be used for " developing specialised materials, and to increase the efficiency of operation."

Nitrile Rubber Used in Gloves

A range of industrial gloves and gauntlets is being made by Dunlop Rubber Company from Hycar nitrile synthetic rubber. They thus inherit the good properties of this British Geon material, including resistance to petroleum products, vegetable and animal fats, oils, alcohols, glycols and many common solvents. The gloves are said to give longer service and greater flexibility than normal solvent resistant gloves, and not to harden. Made in one weight only, sizes 9, 10 and 11, they are available from Dunlop at Cambridge Street, Manchester.

New Alloy for Battery Grids

Work carried out at the Admiralty Materials Laboratory, and reported in the *Journal of the Institute of Metals*, June, 1959, has lead to full-scale trials under service conditions of a lead—3-3·5 per cent tin—0·07-0·1 per cent barium alloy for the positive grids of lead acid batteries. Tin is added to prevent intergranular attack which results from the barium addition. The report shows evaluation of a range of barium, tin, calcium, antimony and selenium containing alloys for corrosion resistance and strength, from which the one alloy was found most promising. The cast alloy forms a tenacious oxide film which should give good contact between paste and grid, and with the increased plate strength—longer life and improved maintenance of charge.

Tougher Vitreous Enamelling

Vitreous enamelling on to steel demands a ground and a cover coat, and in each of these Metal Porcelains Limited of Smethwick, Warwickshire, have made recent improvements. Ground coats have been formulated to provide the required performance at thicknesses of 0·002 to 0·003 in, while recent improvements in titania self-opacified cover coat enamels have been concentrated on two important physical characteristics: raising the coefficient of expansion, and lowering the softening point to give greater fluidity at enamelling temperatures.

Foamed Polyethylene in Coaxial Cable

An American firm is making coaxial cable with a foamed polyethylene core. This is claimed to provide much lower attentuation for a given cable size, and reduces cable weight. Further details may be obtained from suppliers of the foam, Union Carbide International Company, 30 East 42nd Street, New York 17, NY, USA.

Low Temperature Solder for Titanium

The research division of Curtiss-Wright Corporation, Quehanna, Pa, USA, has developed a new silver based solder—Curtisol, and a flux—Curtiflux, expressly for titanium. Efficient joints can be made with an ordinary oxy-acetylene or air-acetylene torch without preheating or special cooling. The solder becomes liquid and flows between 1,300° and 1,400° F, thus enabling joints to be made below the transformation point of titanium. The shear strength of lap joints made three times the thickness of the base metal was 38,000 lb per sq. in.

Cooling Briquettes With Sand

Thirty mesh silica sand is being used at the National Coal Board's Research Establishment at Stoke Orchard to cool briquettes in the absence of air. The sand is recirculated to and from a bunker via a container in which the briquettes are passed, and through a pneumatic transport main in which air takes heat from the sand. At present this is a batch process, but it lends itself to development into a continuous operation.

Drying With No Stains

Wet metal articles may be dried by immersing them in the body or vapour of a boiling solvent such as trichlorethylene, but water stains are not entirely avoided. Trisec is a surface activating agent which is soluble in trichlorethylene, and which, on adherence to metal surfaces, repels water; when wet articles are immersed in boiling solvent containing this agent the water is effectively lifted off the surface. This additive is not lost by drag-out, and is not expensive. Marketed by ICI through all their sales offices, Trisec can be used with standard liquor-vapour decreasing plants, to which it is added in the proportion of 1 part to 80 of trichlorethylene.

Improving Magnetic Iron

That the BISRA annual report came out in May is not news, but at least some of their research projects are timeless: electrical sheet for instance. A reduction in nitrogen content from 0·005 to 0·001 per cent has been found to decrease the hysteresis loss by 20 to 50 per cent in a 3 per cent silicon iron sheet, and this promises a worthwhile reduction of at least 10 per cent in total losses in a transformer steel. Small amounts of titanium form disperse nitrides which allow 0·007 per cent nitrogen to be tolerated with low losses, and a second method for overcoming the effects is being examined in which the sheet metal is coated with aluminium before annealing.

Whisky Prefers Glass Pipelines

Whether or not " whisky is more temperamental than a woman," as distillers claim, this heavenly spirit seems very happy to be flowing through three miles of glass pipeline in the distillery of a Scottish firm, the pipeline, incidentally, supplied and fitted by QVF Limited. The main reason for a change in pipe material was to reduce the copper content of the whisky, which when present in excess of one part per million, may cause haziness (in the whisky, not the drinker). Needless to say, this Scottish firm have taken care that no breakage will occur, and presently report that glass is proving as durable as metal.

Expansion Joint Sealant

Secoflex—made by Secomastic Limited, of Bracknell, Berks—is applied warm and remains flexible on cooling. It is said to have excellent adhesion which is yet improved by use of Secoflex primer on non-metallic surfaces. This bituminous sealant will not slump in vertical joints up to 1½ in wide even at temperatures up to 180° F.

Design

Measuring Transmission Efficiency

The very accurate measurement of power losses in transmission units will be possible with a range of precision dynamometers now being developed. Designed by the Mechanical Engineering Research Laboratory (MERL), East Kilbride, Glasgow, principally for research purposes, MERL is prepared to use them to measure the efficiency of gear boxes and other mechanical transmissions for industrial firms. The fee charged for this work will depend on the time taken to carry out the test.

The largest dynamometer equipment available at present has a maximum input of 75 h.p. at 2,000 r.p.m. Units with a speed ratio of up to 4 : 1 can be tested and efficiency can be measured with an accuracy of about 0·1 per cent of full-scale torque. This equipment consists of an electric driving motor mounted on trunnion bearings with contra-rotating ball-races, and an eddy-current swinging-frame dynamometer (on hydrostatic oil bearings) to absorb the power.

Design on Parade

To be held next February at Earls Court: the Engineering Materials and Design exhibition. On display will be materials and components of interest to the designer in practically every branch of engineering. Concurrently, there will be a conference for engineering designers, where papers will be presented on a wide range of subjects, such as ferrous metals, light metals, refractories, plastics, adhesives, powder metallurgy, rubber, bearings, clutches, seals, drives, couplings, control techniques and appearance design.

Lightning Strike Not Likely

Fire or explosion caused by lightning is impossible, according to a theory advanced by Dipl. Ing. Ernst Rösler of Deutsche Lufthansa.

From time to time we hear of electrical discharges in aircraft. These are caused by aircraft flying into an area of high electrical potential difference, such as exists during thunderstorms between two clouds or between one cumulus cloud and the earth. It is just as though the clouds and earth were acting as a condenser and the air as an insulator. However, the metallic body of the aircraft in the electrical field represents a peculiarity insofar as it is a metallic hollow. Experiments have shown that there is no electrical field (Faraday's cage) inside such a hollow body.

Altitude Warning Device

It is possible to mis-read a conventional altimeter so an altitude warning device has been developed by Mechanism Limited, scientific instrument makers of Croydon, Surrey. Its function is to warn the pilot, by means of a flashing amber light, when he is at 10,000 ft. The device has been designed for use with a new altimeter presentation (evolved by BEA engineers) to replace the widely-used three-pointer instrument. Instead of the third pointer there will be an arc on the dial face which lengthens as the height increases.

It is likely that BEA's Comet and Vanguard (due to enter service next year) will be fitted with this new system.

A Model Diesel

Model aircraft can now be powered by a diesel engine—the Silver Streak—designed by A. E. Rivers (Sales) Limited, Hounslow, Middlesex. This engine has a bore and stroke of 0·5782 in (displacement 2·49 cc) and a maximum b.h.p. of about 0·30 at 16,000 r.p.m.

Its main feature is the original design of roller bearing crankshaft. This has fully-floating spacers in a recessed shaft, instead of the normal cage. Advantages: it saves space and weight and (in this particular case where there is front induction) allows a large centre-section on the shaft. This makes possible a large induction port and an increase in power for this type of

motor. The bearings kept fairly cool on test at over 20,000 r.p.m. for periods up to 100 hours. They are, of course, lubricated by crankcase compression, the fuel containing 25 per cent castor oil.

Acid Bath Milling

A chemical milling system has been built by engineers at the Georgia plant of Lockheed Aircraft Corporation to "melt" surplus weight off the JetStar, their 600 m.p.h., 10-passenger utility jet transport. In this process, etching acids eat away surplus metal in those areas inaccessible to mechanical machining methods.

A wing is first dipped in an etching bath, then into a tank containing a fixing agent, and finally rinsed in water. Each tank is 30 ft deep and of 5 ft diameter. The rate of etching surplus metal is automatically controlled by the speed of immersion and withdrawal from the etching tank. The thickness of a wing panel 30 ft long can be tapered from $\frac{1}{4}$ in at one end to paper-thinness at the other.

Decontaminating Nuclear Effluents

Purchased from the British water treatment firm William Boby and Company Limited, Rickmansworth, Hertfordshire, by the Italian Comitato Nazionale per le Richerche Nucleari: one complete electrodialysis stack (of the type pioneered by Boby) as a research project for experiments in the decontamination of nuclear effluents.

The heart of any electrodialysis plant is the stack, which consists essentially of anionic and cationic membranes arranged alternately between two electrodes, connected to a d.c. source. When saline water is passed through, desalting takes place in every second compartment. The sodium and chlorine ions thus removed are built up in the other compartments and the process continued until there is the required reduction in salinity.

A similar stack at Tobruk is daily producing 12,000 gallons of fresh water from brackish desert wells.

ELSIE the Electronic Sorter

Post Office engineers have designed an eletronic letter sorter called ELSIE. The machine takes letters one at a time from a stack and an operator reads the address (in code), presses two typewriter-like keys and the machine then "knows" into which of 144 pigeon holes the letter must fall.

The basic component of this postal code translator is a magnetic annulus with a strong hysteresis characteristic, the so-called square-loop magnetic core. The particular core employed is formed by winding specially prepared nickel-iron alloy tape, $\frac{1}{4}$ in wide by 0·00125 in thick, into the form of a 1 in diameter ring. The material has a saturation flux density of 8,000 gauss and a ratio B_{rem}/B_{sat} of about 0·8. The system is being tried out as an experiment in Norwich.

You Want the Best Designers . . .

Recently Sir Colin Anderson (a member of the Council of Industrial Design, 28 Haymarket, London, SW1) addressed Welsh industrialists on the subject "Design Policy in Industry."

He made the interesting point that the Design Centre (operated by the CoID) keeps an up-to-date record of approved designers.

Locomotive Gas Turbines

Gas turbines will have to be further developed if they are to compete with diesel locomotives using electric or hydraulic transmissions. This is the opinion of Mr. D. C. MacPhail of the National Research Council, Ottawa, given in a recent lecture.

The gas turbine (using low grade fuels and waste heat) can make big cuts in fuel costs. To do this, however, the locomotive will need an idling fuel consumption cost similar to that of the diesel.

Construction

Europe's First Terminal for Super Tankers

The first terminal in Europe capable of berthing at any tide fully-loaded super tankers of 100,000 dw tons or more was opened at Finnart, Loch Long, off the Firth of Clyde, during June. It belongs to the British Petroleum companies and crudes brought to the terminal will be pumped through a 57 mile pipeline to Grangemouth refinery on the Firth of Forth. Tankers will be able to discharge 6,000 gallons of crude oil an hour.

The head of the jetty is 330 ft long and is 180 ft from the shore, to which it is connected by four shore arms for the pipe track and light vehicles. The minimum depth available at low water is 55 ft. The consulting engineers were Rendel, Palmer and Tritton of London; the contractors for the jetty were Melville, Dundas and Whitson Limited, Glasgow, and, for the onshore facilities, George Wimpey and Company Limited, London.

Civil Work Starts at Trawsfynydd

Civil engineering work on the site of the Trawsfynydd nuclear power station began during the last week in June. The fifth nuclear station to be begun in Britain, it will have an output of 500 MW and is the first to be located in Wales. The contractors are Nuclear Civil Contractors, a partnership of Trollope and Colls Limited, and Holland and Hannen and Cubitts Limited.

The site will be laid out in terraces, involving the excavation of 500,000 cu. yd, including a large amount of rock blasting. Precast-concrete panels will clad all the buildings, using local aggregates so that the finished work will harmonise with the surroundings. The panels, weighing 5 tons or more each, will span 15 to 27 ft between columns. Consulting engineers to Nuclear Civil Contractors are Mott, Hay and Anderson of London.

Progress at Kariba

Reports from Kariba show that the great wall of the dam has been completed. It was, it will be remembered, only in February, 1958—18 months ago—that the cofferdams around the foundations were flooded by the exceptional flow of the Zambesi. The dam is 2,000 ft long at the crest and is 400 ft high at the centre; altogether there is about 1·3 million cu. yd of concrete in the wall.

R.C. Bridge with 900 ft Span

A contract valued at £A2,400,000 for a new bridge in Sydney Harbour, across the Parramatta River, has been let to a consortium comprising Reed and Mallik of Salisbury, England, and Smart Bros. of Sydney. The total length of the bridge is 2,000 ft, with a central arch span of 910 ft, to give a maximum clearance over the water of 120 ft. The reinforced concrete arch is claimed to be the largest of its type in the world. Six traffic lanes and two pavements for pedestrians will be provided over the bridge. The consultants are G. Maunsell and Partners of London.

High Strength Bolts in the UK

The symposium on high-strength bolts for structural steel connections, sponsored by the Institution of Structural Engineers, was held in early June.

The present position in the United Kingdom is that a draft British Standard covering the manufacture of the bolts is soon to be issued. There is, however, no immediate prospect of a standard covering their use, though BSI have this under consideration and research work is in hand. British engineers have made much use of such bolts and recent examples where they have been employed include the bridges over the Volta River and at Auckland Harbour. The upper part of the tower for the Shell building on London's Southbank is also being assembled using high-strength bolts to counter wind loads.

Structural Steel for Buildings: BS 449

British Standards have issued their revised specification BS 449, *The Use of Structural Steel in Building*, incorporating the parallel code of practice, CP 113. The standard costs 15*s* (postage extra to non-subscribers).

The clauses relating to the design of members subject to bending, compression and tension have been rearranged in separate groups, each containing the basic information for the design of a particular type of member. The amended conditions for cased stanchions have been introduced, allowing full account to be taken of the contribution made by the concrete.

Tancarville: Europe's Longest Suspension Bridge

Tancarville road bridge, of 2,000 ft clear span and, at present, the longest suspension bridge in Europe, has been open to traffic for some weeks and was inaugurated by the French Minister of Works on 25 July. It crosses the estuary of the Seine about 25 km from Le Havre and cuts the road route between north and south Normandy by many miles. Hitherto, the first crossing of the river has been at Rouen, 60 km from Le Havre.

Prominent features of the bridge are the two massive towers, 390 ft high, of reinforced concrete. The deck is of composite steel and concrete and acts as the top chord of the stiffening trusses. A toll, starting at Ft 400 for the smallest vehicles, will be charged, at least until the capital charges have been met.

Trial Trip for Big Dredger

A new rock-cutting suction dredger, the "Port Sunlight," built by and belonging to the Westminster Dredging Company Limited of Bromborough, Cheshire, had a trial run on the Mersey during the middle of July. The Port Sunlight is believed to be the most powerful of her type yet built in Europe and has been designed to cut soft and medium-hard rocks as well as to operate above granular beds.

She can work in depths up to 65 ft of water. Accommodation is provided for a crew of 21. Hull dimensions are: overall length, 168 ft; beam, 42 ft and depth, 12 ft.

December Start on Aswan Dam

Various reports from Cairo at the end of June indicate that the new dam at Aswan will be begun in December of this year. The reports are conflicting in detail but it would seem that the amended scheme is smaller and less ambitious than the original High Dam project.

The wall will be shorter; a single open cut with short tunnels will replace the originally suggested seven diversionary tunnels; the gates will be made of cheaper steels; and a pebble filling, instead of sand, will be used. It is now thought that the dam can be built in one stage instead of two, and that the project can be completed by 1968.

Cwm Rheidol Hydroelectric Scheme

A contract valued at over £1 million has been let by the Central Electricity Generating Board to Taylor Woodrow Construction Limited for construction of the hydroelectric power scheme at Cwm Rheidol, in Cardiganshire, Wales.

The new contract covers a 700 ft long concrete gravity dam 40 ft high; a tunnel, 9 ft 6 in inside diameter and 2,200 ft long; a 150 ft deep surge tank and a pressure shaft 10 ft in diameter to a further depth of 510 ft; and the power station for the two 180 MW turbo-alternators.

The consulting engineers are Freeman, Fox and Partners, of London, in association with James Williamson and Partners.

Operation and Maintenance

Trucks for Soft Terrain

Six special motor trucks supplied to Shell Condor S.A. for use in the soft terrain of the Llanos region of Colombia, will carry oilfield equipment to places hitherto only approachable by helicopter or costly tracked vehicles. The trucks are standard Bedford vehicles, modified by All Wheel Drive Limited, Camberley, Surrey, and fitted with "Terratires," 40 in diameter and inflated at between 5 and 15 lb per sq. in. Ground bearing pressures are less than exerted by a man, and the vehicles will run over soft ground at 20 m.p.h. A load of 400 lb can be carried by the trucks in swampy areas. With special Terratired Dyson trailers they will transport 10,000 lb.

Tar Distillery Pipe Cleaning

Striking economies in the cleaning of tar heater, heat exchanger and condenser pipes are claimed as a result of a cleaning operation carried out at the Preston works of Lancashire Tar Distillers Limited. Using Lagonda motors and cutter heads, made by the Consolidated Pneumatic Tool Company Limited, 232 Dawes Road, London SW6, dense, gummy tar deposits, of uneven thickness, were removed from tar heater tubes. A typical operation was the cleaning of 202 tubes of 3½ in inside diameter, the average time being from 20 min to 1 hour per 15 ft tube.

Coal in Smokeless Areas

Coal buring furnaces fired by mechanical stokers have now been approved for use in smoke control areas. Under the Clean Air Act, 1956, the Minister of Housing and Local Government can make Orders exempting specified types of apparatus, and such an Order has now been issued in respect of mechanical stokers installed on or after 31 December, 1956. The National Coal Board have undertaken to make available supplies of suitable fuel.

Savings with Diesels

Three nomograms devised by Perkins Engines Limited, Peterborough, show the savings resulting from the substitution of diesel engines for petrol engines in road vehicles. One nomogram enables a vehicle user to determine fuel savings per mile, total fuel savings at various given mileages, and critical mileage, or the mileage at which the cost of the diesel engine can be recovered at a given fuel saving per mile. The second nomogram provides similar information on a metric basis, and the third enables operators to determine quickly the annual or total cost of a diesel engine after deduction of investment and income tax allowances.

Speeding Diesel Locomotive Maintenance

A new wheel profile truing machine installed by British Railways in their Eastern Region Locomotive Works at Stratford, London, E15, has reduced the time required for wheel truing on diesel and diesel electric locomotives from days to hours. Made by the North British Locomotive Company Limited, Glasgow, for the Atlas Engineering Company, London, SW7, the machine is housed in a pit below the rails and machines the wheel profiles, by a milling process, without the necessity for any dismantling of the wheel assemblies, brakes or drive mechanisms.

Speech Communication in Steelworks

Installed by Tannoy Products Limited, the speech communication system at the Lackenby Works, Middlesbrough, of Dorman Long (Steel) Limited, is the basic means of production control. The system, which is now nearing completion, will be the most comprehensive in Great Britain. Transistors and advanced electronic design are features of the equipment. Where a connection to travelling cranes is required, the Tannoy patented induction loop system is used, which provides inductive coupling without the need for trailing cables.

Safe Gas Cylinder Storage

Gases stored under pressure in cylinders may be dangerous if they are mishandled or become involved in a fire. To provide guidance for those responsible for storing such cylinders the Fire Protection Association, 31-45 Gresham Street, London, EC2, have issued a technical information sheet (No. 3011). It stresses the need to store cylinders away from any source of heat, including that of the sun, gives general suggestions for using and handling the cylinders and advice on action to be taken in the case of fire, pending the arrival of the fire brigade. Oxygen is dealt with in a separate sheet (No. 3013).

Aircraft Service Record

Ten Fiat G91 fighters, powered by Bristol-Siddeley Orpheus engines achieved in recent tactical trials a record of 100 per cent serviceability. Operating from grass landing strips, under both muddy and dusty conditions, the aircraft carried out nearly 170 sorties, with a total flying time of some 150 hours. As a demonstration of engine servicing a complete engine was removed and a new one was fitted in 42 minutes.

Maintaining Dust Collectors

Dallow Lambert and Company Limited, Thurmaston, Leicester, have introduced a scheme for regular maintenance of their unit dust collectors. It is claimed to be the first scheme of its kind in this country. A fully trained service engineer makes visits at regular intervals, and services each dust collector, replacing any parts as required, to keep the equipment in first class working condition. Every firm participating in the scheme is provided with a maintenance service register.

Production

Low-Cost Tooling

"Epikote" resins made by the Shell Chemical Company Limited, 170 Piccadilly, London, W1, have enabled Saunders-Roe Limited, East Cowes, Isle of Wight, to reduce the cost of making jaws for a Hufford stretch-forming machine. The jaw bodies are made from a metal power filled resin mix and the actual gripping surfaces are short lengths of file inserted in the plastic surfaces. The cost of the jaws is about £10 to £16, compared with £70 to £80 for steel jaws.

Continuous Glass Tubemaking

Lead glass tubing is now being made by a continuous process by Chance Brothers Limited, Smethwick, Birmingham, at speeds of up to 2,000 ft per min according to size. This is the first instance in the United Kingdom of lead glass tubing being produced by the "Vello" process, which works to close dimensional limits and has a size range from 1½ to 60 mm diameter. The Vello plant, which has already been in operation for some time on soda lime glass, is now running alternately on this material and on lead glass.

Leak Detection by Vacuum

Vacuum techniques for leak detection are being used increasingly for testing such diverse products as oil drums, high pressure boilers, sealed instruments, liquid gas vessels, and mercury arc rectifiers. Edwards High Vacuum Limited, Crawley, are marketing leak test pumping units specially designed for this work. The latest addition to their range uses a 9 in bore oil diffusion pump, and is designed for large pressure vessels where separate "roughing" pump facilities are required.

Oxygen Steelmaking

The second open hearth steel furnace to be converted to the "Ajax" oxygen process at the works of the Appleby-Frodingham Steel Company, Scunthorpe, achieved a record output of 4,254 ingot tons during its first operating week. Modification of an open hearth furnace to the Ajax process, which was an Appleby-Frodingham development, costs much less than the installation of any other oxygen steelmaking process, and can be carried out in from 4 to 8 weeks. Combined output of the two Ajax furnaces is expected to be about 9,000 tons per week with an average fuel consumption of under 10 therms per ton.

Mechanical Finishing Development

A range of metal finishing machines, based on a new principle, is to be made available soon in Great Britain by Roto-Finish Limited, Mark Road, Hemel Hempstead. A vibratory motion is used in place of the well-known rotary movement. It is claimed that the new principle gives faster and better descaling, deburring, and similar operations.

Restyled Electric Furnaces

Birlec Limited, Erdington, Birmingham, 24, announce the introduction of a new range of box-type electric furnaces for toolroom use and general heat treatment. Restyled to improve their appearance and ease of operation, and to rationalise their production, the furnaces are also reduced in price. Five furnaces to operate up to 1,000° C, and four for operation up to 1,400° C are available, the sizes being from ¼ to 3 cu. ft and the ratings from 16 to 60 kW.

Grinding Machine Film

Under the title "Precision Plus Production," the Churchill Machine Tool Company Limited, Broadheath, Manchester, have produced a sound colour film featuring their model NB horizontal spindle grinding machine. Running for 22 min, the film describes in detail the construction of the machine and the type of work it will do, including form grinding. The film is available on free loan from Sound Services, Wilton Crescent, Merton Park, London, SW19.

New Packaging Material

"Carbion," a new packaging material introduced by Spicers Limited, Langston Road, Loughton, Essex, offers a high degree of protection combined with low cost, and is easily applied to components of irregular shape. It is made by passing straw paper or other suitable material through heated profiled rolls which give it a ridged pattern somewhat similar in appearance to ordinary corrugated paper. Unlike the latter, however, Carbion recovers its shape and cushioning property when the load is removed.

Flame Cutting

Introduced by the Linde Department, Union Carbide International Company, 30 East 42nd Street, New York 17, NY, USA, the "Oxweld" CM60 flame cutting machine has a photoelectric tracing system which compensates automatically for the width of cut. Parts can thus be reproduced from an exact sized drawing. Standard models can be equipped with 10 torches to cut any width up to 10 ft, and the machine is controlled by an operator seated at a control panel.

Drilling in Safety

One of the reasons why drill guards are sometimes not used in production drilling is the fact that simple, easily applied guards are not always available. A telescopic guard, made by William Jones Limited, 1 Fitzroy Square, London, W1, has been generally accepted in safety circles, and a range of guards has now been put into production. Models are available as treble or double draw telescopic units for use on any type of drilling machine from pedestal to radial.

Microporosity in Steel Castings

Investigations carried out by the British Steel Castings Research Association, Sheffield, have confirmed that there is a close quantitative correlation between microporosity and ductility.

Steel castings have been examined by a newly developed technique known as semi-micro-radiography. This involves the use of specimens ground to 0·020 in thickness and less, from which high resolution X-radiographs are produced. These are assessed by a counting technique which gives a quantitative indication of the microporosity of the sample.

Investigations into the effects of pouring temperature and composition are being made by BSCRA and a number of castings have been made using compressed air feeder heads. Both semi-micro-radiographic and tensile test results have so far indicated that pressure feeding does not improve soundness and mechanical properties.

Data by Telephone

A new coding system, developed by the Bell Telephone Laboratories, USA, is expected to increase the reliability of digital pulsed data transmitted along telephone cables. Using the redundancy principle, the new system adds extra pulses in a continuous flow. The code will correct bursts of errors such as those caused by lightning flashes. The encoding and decoding equipment is said to be less expensive than that of previous systems.

Hydraulic Transport of Solids

Experimental work described by the British Hydromechanics Research Association has shown that it is now possible to design, on an empirical basis, pipelines to transport widely varying solid/liquid mixtures. Three principle flow regimes are possible: (1) slurries of particles less than 30μ have plastic flow properties and a prediction of full-scale head loss can be made from viscometer tests; (2) particles in the range 0·002 in to 0·008 in travel suspended in turbulent liquid and the head losses are a function of the increased density of the mixture; (3) particles larger than 0·008 in travel partly in suspension and partly by sliding. For this third class of material, Durand's correlation on the basis of particle drag coefficient has been found to be satisfactory.

Transatlantic Television

A system developed by the BBC for transmitting brief film sequencies across the Atlantic was used for the first time on 18 June. Pictures of the Queen's departure for Canada were shown in North America within two hours of the event. The pictures were transmitted over the transatlantic telephone cable normally used for sound.

A slow-speed flying spot film scanner develops a video signal which is used to modulate the carrier at the transmitting end. At the receiving end the signals are demodulated and used to operate a slow speed film telerecording unit. The bandwidth of the system is about 4·5 kc/s Scanning time is about 100 times greater than normal.

New Director for NCL

The appointment has been announced by the DSIR of Professor J. S. Anderson, F.R.S., as director of the National Chemical Laboratory. He will succeed Dr. D. D. Pratt later this year. J. S. Anderson, who is professor of inorganic and physical chemistry at Melbourne University Australia, is widely known for his contributions in the fields of solid state chemistry and the chemistry of complex salts.

5 kW Thermoelectric Generator

A 5 kW generator to convert heat energy directly into electricity is to be designed and constructed by Westinghouse Electric Corporation, USA. This will be the first major step toward solving the problems of large scale thermoelectric power plant.

The generator, which is to be built for the US Navy, is intended as a basic design for a ship-board installation. Features will be noiseless running and shock and vibration resistance. Sea-water may be used for cooling.

Giant Radio Telescope

A new radio telescope, which will be the world's largest, is to be built at West Virginia, USA, by the US Navy. When finished, in 1962, its 600 ft reflector will dwarf that of Jodrell Bank which is 250 ft in diameter. A system of servo motors will be used to maintain accurate alignment of the sections of the 20,000 ton reflector against distortion caused by wind and temperature. An inertial guidance system will direct the telescope which, it is hoped, will detect signals from sources up to 38,000 million light years away.

High Speed Pulse Monitor

An oscilloscope has been developed which will meet the requirements for displaying and measuring pulses in the range 3 mμ secs to 3 mμ secs. Originally designed at the Atomic Energy Research Establishment, Harwell, the sampling oscilloscope, as it is called, has been developed commercially by Mullard Equipment Limited. High sensitivity and d.c. coupling are features which make this instrument particularly suitable for transistor circuit use. It should also prove valuable in nucleonic, computer and radar research.

British Satellite Planned

Following the return of Professor H. S. W. Massey from his talks in the USA, preliminary plans have been announced for the first British satellite. The United States have agreed to provide the vehicle and launching facilities for a 150 lb satellite which will measure about 20 in in diameter. Sir Edward Bullard, chairman of the steering group on space research, has commented that it will take about two years to develop and manufacture the instruments and container for the first launching. Probably three satellites will be launched over a period of about four years, involving a cost of between £100,000 and £200,000 per year.

Atomic Power Centre Opened

Whetstone Works, Leicester, which is the atomic power centre of the English Electric Company Limited, was officially opened by the Minister of Power, Lord Mills, on 24 July. These works are also the headquarters of the consortium which designed and is building the 500 MW atomic power station at Hinkley Point. One of the most recent additions to the many research facilities at Whetstone is the new Toxic Laboratory in which experiments can be made on uranium and beryllium and also on complet-fuel elements made for proving in a reactor.

Timber Fire Hazards

Fire hazards associated with the prolonged heating of structural timber at moderate temperatures have for a long time been a matter of uncertainty. At one time, work carried out under the direction of the Fire Research Board of the DSIR seemed to indicate that the ignition temperature of wood was lowered by such treatment. However, in their latest annual report (obtainable from HMSO, London, 5*s*) the Fire Research Board state that more recent and thorough work in this field has shown that no such reduction of ignition temperature occurs.

1,000 Megohm Standard Resistor

Following their successful completion of a 100 megohm resistance standard, the National Physical Laboratory are constructing a similar standard at 1,000 megohm. It will consist of nickel chromium aluminium iron wire, 0·0006 in diameter, specially drawn down and enamelled, wound on mica cards. The standard will be made up of units of about 30 megohm resistance which are being wound as the special wire becomes available from the manufacturers.

Overseas Research Council Formed

An Overseas Research Council, which will provide for the coordination of assistance and for the formulation of a United Kingdom policy in this field, is to be established. In a statement to the House of Lords defining the aims of the council, Viscount Hailsham said: "There are no geographical restrictions in the council's terms of reference. Matters concerning scientific development in colonial territories, Commonwealth countries and in countries outside the Commonwealth can equally be referred to it. In promoting such development, the council can look to possible collaboration between this and other Commonwealth countries, countries outside the Commonwealth, such as the United States, and international agencies."

Exhibitions and Conferences

Radio and Television Exhibition, 26th National.—Wed., 26 Aug., to Sat., 5 Sept., at Earl's Court, London, SW5. Organised by Radio Industry Exhibitions Ltd., 17 Fleet Street, London, EC4. Tel. FLEet Street 8271.

Leipzig Autumn Fair.—Sun., 30 Aug., to Sun., 6 Sept., at Leipzig. Fair offices: Postschliessfach 329, Leipzig, C.I., Germany. Agents: Leipzig Fair Agency, 39 St. James's Place, London, SW1. Tel. HYDe Park 3111. (Agents' new address and telephone number.)

Handicrafts and Do-It-Yourself Exhibition, Seventh.—Thurs., 3 Sept., to Sat., 19 Sept., at Olympia, London, W14. Offices: 24 Store Street, London, WC1. Tel. MUSeum 9792.

Scottish Industry Exhibition.—Thurs., 3 Sept., to Sat., 19 Sept., at the Kelvin Hall, Glasgow. Exhibition offices: 2 Woodside Terrace, Glasgow, C3. Tel. Douglas 9911. Information also obtainable from the Scottish Council (Development and Industry), Century Insurance House, King Street, London, SW1. Tel. TRAfalgar 6681.

Farnborough Flying Display and Exhibition.—Mon., 7 Sept., to Sun., 13 Sept., at Farnborough, Hampshire. Open to the public on Fri., Sat. and Sun., 11, 12 and 13 Sept., only. Organised by the Society of British Aircraft Constructors, 29 King Street, London, SW1. Tel. TRAfalgar 3231.

Packaging Exhibition, Sixth.—Tues., 8 Sept., to Fri., 18 Sept., at Olympia, London, W14. Organised by Provincial Exhibitions Ltd., City Hall, Deansgate, Manchester. Tel. Deansgate 6363.

Institute of Physics; Stress Analysis Group: Annual Resident Conference.—Wed., 16 Sept., to Fri., 18 Sept., at Birmingham University. Apply to Mr. J. Lawrence, Institute of Physics, 47 Belgrave Square, London, SW1. Tel. BELgravia 6111.

Business Efficiency Exhibition.—Mon., 12 Oct., to Sat., 17 Oct., at King's Hall, Belfast. Organised by Office Appliance and Business Equipment Trade Association, 64 Cannon Street, London, EC4. Tel. CENtral 7771.

Engineering Industries Association's Twelfth Engineering Display.—Tues., 20 Oct., to Thurs., 22 Oct., at the Royal Horticultural Society's new hall, Greycoat Street, London, SW1. Association's offices: 9 Seymour Street, London, W1. Tel. WELbeck 2241.

Motor Exhibition, 44th International.—Wed., 21 Oct., to Sat., 31 Oct., at Earl's Court, London, SW5. Organised by the Society of Motor Manufacturers and Traders Ltd., Forbes House, Halkin Street, London, SW1. Tel. BELgravia 6611.

Industrial Efficiency and Safety Exhibition.—Tues., 3 Nov., to Sat., 14 Nov., at the City Hall, Deansgate, Manchester 3. Organised by Provincial Exhibitions, Ltd., City Hall, Deansgate, Manchester. Tel. Deansgate 6363.

Automation Congress and Exposition, Fifth International; and Second Military Automation Show.—Mon., 16 Nov., to Fri., 20 Nov., at the New York Trade Show Building, New York. Organised by Richard Rimbach Associates, 846 Ridge Avenue, Pittsburgh 12, Pa., USA.

"Model Engineer" Exhibition.—Wed., 30 Dec., to Sat., 9 Jan., 1960, at the Royal Horticultural Society's new hall, Greycoat Street, London, SW1. Organised by The Model Engineer (Percival Marshall and Co., Ltd.), 19-20 Noel Street, London, W1. Tel. GERrard 8811.

Cleaning and Maintenance and Floor Trades Exhibition and Convention, First.—Mon., 1 Feb., to Fri., 5 Feb., 1960, Royal Horticultural Society's old hall, Vincent Square, London, SW1. Organised by Contemporary Exhibitions Ltd., 40 Gerrard Street, London, W1. Tel. GERrard 4951.

British Toy Fair.—Mon., 15 Feb., to Fri., 19 Feb., 1960, at Brighton. Organised by the British Toy Manufacturers' Association, 93-94 Hatton Garden, London, EC1. Tel. CHAncery 9158.

Engineering Materials and Design Exhibition and Conference, First.—Mon., 22 Feb., to Fri., 26 Feb., 1960, at Earl's Court, London, SW5. Organised by Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Electrical Engineers Exhibition, Ninth.—Tues., 5 April, to Sat., 9 April, 1960, at Earl's Court, London, SW5. Sponsored by the Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1. (Tel. LANgham 5927); and organised by Electrical Engineers (ASEE) Exhibition, Ltd., 6 Museum House, 25 Museum Street, London, WC1. Tel. MUSeum 3450.

Institution of Naval Architects, Centenary Meeting.—Mon., 16 May, to Fri., 20 May, 1960, in London. Institution offices: 10 Upper Belgrave Street, London, SW1. Tel. SLOane 4622.

AEI Reorganise

The year 1959 will long be remembered within Associated Electrical Industries as the year of major changes. The group have been divisionalised and in July became a vast organisation operating on product lines. Lord Chandos, AEI's chairman, formally announced this in June. Instead of trading through subsidiaries both at home and overseas, AEI now operate through nine divisions whose business is conducted in the United Kingdom by 23 district offices. Overseas sales are handled by a new company, Associated Electrical Industries Export Limited, who have taken over all the export business of the old subsidiaries. Export markets are divided into nine areas, in four of which—Canada, New Zealand, South and Central Africa and Brazil—new AEI overseas companies are being formed.

The nine product divisions of the group are: turbine-generator; heavy plant; motor and control gear; switchgear; transformer; electronic apparatus; traction; SES cables, and SE, telecommunications. Hotpoint retain the marketing of their domestic appliances. In every case except Hotpoint and Siemens Edison Swan, the name of AEI is to be promoted in place of the old company names As previously announced, Metropolitan-Vickers are to act as managers of the divisions " concerned with the generation and distribution of electricity,' while British Thomson-Houston will manage divisions " concerned with the application of electrical power." New product divisions will be formed in due course.

The main purpose of the reorganisation, Lord Chandos explained, was " to meet the intensely competitive conditions within the electrical industry." As in the case of electrical cables the ending of price agreements, due to the Restrictive Practices Act is increasing competition and further amalgamations within the industry can be expected. The group's reorganisation will help to eliminate overlapping by companies within the group in matters of research and re-equipment. It is also likely to foster a more single-minded approach to the development and marketing of the group's products.

Imperial Aluminium Company

The agreement between Imperial Chemical Industries Limited and the Aluminium Company of America (Alcoa) to collaborate in the manufacture of wrought aluminium products is yet further evidence that this is a field in which the American's hold so big a hand that it is difficult to operate successfully without their help. The deal between Reynolds Metals and Tube Investments first in the reorganisation of TI Aluminium and then in their extension through the purchase of British Aluminium showed quite clearly that this was so. Already Northern Aluminium were associated with the Aluminium Company of Canada (Alcan). Now that Alcoa have come in with ICI, Kaiser are the only major North American producers without a substantial stake in the British aluminium industry, although they collaborate closely with Hawker Siddeley's High Duty Alloys.

ICI came into the aluminium business rather late, probably influenced by the Ministry of Supply for whom they ran a factory in South Wales. Their plant is at Waunarlwydd near Swansea, where capacity is between 20,000 and 30,000 tons a year, or about 8 to 9 per cent of the British market. Redundancy was imminent but action has now been postponed until Alcoa have had time to examine the situation.

Imperial Aluminium, whose capital is held by ICI and Alcoa in the ratio of 51 : 49, have assets of £10 million. ICI have appointed three of the five directors, including the chairman, Dr. J. Taylor, and the managing director, Mr. Berkeley Villiers. Initially the company's products are being sold through ICI selling offices. ICI's general personnel policy applies to the new company which, apart from a limited number of technical staff on secondment from Alcoa, employs United Kingdom staff and workers.

Machine Tool Trading

The results, recently announced, of two large machine tool firms show that the effect of the distressing slump of the past two years has had a varying impact on the industry. A. A. Jones and Shipman of Leicester, who are one of the country's leading makers of grinding and honing machines and small tools, experienced a lower scale of trading. Trading profits were less than half the previous year's, having dropped from £461,000 to £216,000. Mr. F. G. Morris, the company's chairman, commented that the fall in turnover had been " in these standard machines upon which a high rate of profit is slower when production is high." In an effort to maintain sales, they were forced into dealing with a wider range of designs, and profit margins were sharply reduced. A loss was incurred by their Canadian company and the situation there and in the United States was described by Mr. Morris as " a constant headache " to the board during the year. The poor commercial prospects caused the company " to put into cold store for a more propitious period " plans which had been prepared for extensions to the Leicester works. Mr. Morris was not very hopeful of a recovery during the current year: " the volume of increasing orders is still well below our productive capacity," he said, "there is a tendency to pick up slightly but the volume is not good."

Craven Brothers, on the other hand, succeeded in increasing their trading profits from £290,000 to £300,000. Their new managing director, Mr. James Lauchlan, who took over following the death of Mr. J. R. Greenwood last March, comments that " trading conditions during the year have been very difficult and deliveries have exceeded the intake of new orders during the year." Despite this, the company still had a satisfactory order book at the end of the year. Mr. Lauchlan is clearly more optimistic than Mr. Morris. Although he points out that the difficult trading conditions continued into 1959, he notes that recently orders and inquiries have increased in volume and anticipates that tax concessions in the recent Budget " will encourage users to renew their equipment and extend their plants."

Thrust Without Drag

The American Newcomen Society honoured one of the pioneers of the United States aircraft industry when Mr. H. M. Horner, chairman and chief executive of United Aircraft Corporation, delivered the Newcomen address, in which he discoursed on the history of his company. Mr. Horner is a product of the Sheffield Scientific School of Yale University, and admitted a passion for aviation "as far back as I can remember." His first job was that of progress chaser at Pratt and Whitney Aircraft Company (now a division of United Aircraft). In 1940 he was appointed general manager, two years later, vice-president and director of United Aircraft, and, in 1943, when he was only 40, was elected president of the corporation.

United Aircraft are an organisation of 60,000 people, organised into five divisions, each of which places particular emphasis upon engineering. Each division, with the exception of the missiles and space systems group, is a pioneer in the design, development and construction of aeronautical products. " Each," said Mr. Horner, " is peculiarly the product of a handful of men, many of whom are still alive and active, whose careers bridge most of the years covered by the history of manned flight."

Several of these pioneers were mentioned by Mr. Horner. The first was Frederick Brant Rentschler who died in 1956. He formed Wright Aeronautical Corporation, which he directed from 1919 to 1924. A year later he established Pratt and Whitney Aircraft and picked six men—Mead, Willgoos and Ryder, all gifted engineers, and Brown, Marks and Borrup, each with wide machine shop experience. Mead and Willgoos respectively conceived and refined the radial air-cooled Wasp engine, delivering 415 h.p. for 650 lb of weight. The Wasp and its sister engine, the Hornet, established " altogether new criteria in the aircraft engine field." Ten years after the Wasp went into commercial service, " the American flag became the first to span both Atlantic and Pacific oceans in commercial airline service." The review of progress to the present day is an absorbing story. Its highlights are the development of the " constant speed propeller " (Hamilton Standard, licenced to de Havilland during the war), the helicopter (Sikorsky Aircraft is in the group), and versions of the jet engine (J.57 and J.75). The shaft horsepower of the latter, some 100,000, compares with the 400 of the first Wasp.

Cementation Get Together

A total of one hundred senior executives from twelve countries, including Britain, took part in a 12 day international management conference held recently by the Cementation group of companies, who operate internationally in the fields of mining and civil engineering. This was the first group management conference to be held and its theme was " the role of management in an expanding group." The delegates attending included directors of a number of the group's subsidiaries, who travelled by air (accompanied by their wives) from Brazil, Canada, Republic of Ireland, France, India, Iran, Morocco, Portugal, South Africa, Southern Rhodesia and Spain.

Part of the conference took place at the Kensington Palace Hotel in London, where delegates participated in discussions on a wide range of management subjects and had an opportunity for an exchange of views, especially on ways and means by which the group's varied technical resources can be further exploited in international markets.

Hail and Farewell

One of the best known personalities in British engineering retired from business earlier this year. He is Mr. Harold Gwynne Allen, M.A. (Cantab.), M.Inst.C.E., M.I.Mech.E., who has given a lifetime of devoted service to W. H. Allen Sons and Company of Bedford. Mr. Allen is the oldest surviving son of William Henry Allen who founded the business in 1880. He has served for over 50 years as a director of the company, and has been deputy chairman since 1928. In his younger days he worked in various departments of the firm, being particularly concerned with the development of their commercial organisation. There are very few engineers who have done as much to further the development of their industry. Quite rightly, he has been described as " one of the fathers of technological education combined with engineering training " and he has played an active part in pioneering the careers of many engineers who today hold important positions in all parts of the world.

An important new appointment has been made to the deputy chairmanship of ASTA (the Association of Short-Circuit Testing Authorities Inc.). The new deputy chairman is Mr. J. R. Wilkinson, who has been a member of the ASTA management committee since the association was incorporated in 1938, and was appointed to the Council in 1942. He is managing director of Ferguson Pailin, a director of Switchgear Testing Company and a member of the BEAMA Council.

Foremen Taken Seriously

More is being done in the United States than in Britain to help the foreman to develop his managerial skills and to make his work more congenial. This was one of the main conclusions drawn by Mr. H. A. C. Tracey, general secretary of the Institute of Industrial Supervisors, after a two-month study of American supervision. Mr. Tracey, whose visit to the US in October and November last year was sponsored by a number of British companies, produced a most interesting report which has been published by the Institute under the title *Further Along the Road*.

It is based on many intimate contacts with foremen " from places as far apart as Boston, Birmingham (Alabama), Canada and New Mexico, and drawn from industries as diverse as ballistic missiles and breakfast cereals." He attended the annual conference of the National Management Association and discussed supervisory training with university lecturers in Southern California and in Washington. Through the NMA, Mr. Tracey was able to examine the many aspects of the association's work in this field which is carried out by maintaining close contact with 65,000 supervisors spread through 330 management clubs. He also studied the functions of the National Council of Industrial Management Clubs, which directs the activities of 33,000 supervisors who are members of 225 clubs.

Mr. Tracey did not find the standard of foremanship in the US greatly superior to the standard in Britain. He did find, however, that the American foreman has more general encouragement to join a management club. He writes: " More is being done in America by more people. The idea that foremen and supervisors need training and should play an active part in an organisation of their own has had more years in which to become accepted and practised. Individual members undoubtedly give more time to a club's affairs, once they have joined it. There is more awareness generally of the opportunities for advancement which active participation in club affairs can ultimately provide. There is the undoubted spur of a generally faster tempo."

There are many valuable suggestions in this report for improvements in supervisory training, and in the standards of sectional activities of the Institute of Industrial Supervisors.

There is also a need for British industry to consider " further help, direct or indirect . . . to the overall stimulation of improved standards of supervisory management." An interesting difference between the two countries is that in the US there is a fear in most sections of industry that the supervisor will join a foreman's trade union, despite the fact that the Taft-Hartley Act excludes supervisors from bargaining processes. " This fear," states Mr. Tracey, "has undoubtedly stimulated greatly the considerable attention being directed to supervisory training in all its forms and to the spreading of the idea that the foreman is part of the management."

Neither Tycoon Nor Frontiersman

Recently Mr. Crawford H. Greenewalt, president of E.I. du Pont de Nemours and Company, gave an address to the North Carolina Citizens Association on the subject of "A Political Role for Businessmen." Briefly, he deplored the antagonism commonly expressed in the United States to the business community as such, the animosity of business to government and politics, and called for a more active participation by business men in politics. It was apparent from what he said that in his view the businessman of today is heterogeneous as a type but basically a professional business executive, a man trained in orderly thinking and attracted to processes of organisation.

There is much to be said on this theme but one point is apparent. This type of businessman, and he is certainly becoming more numerous in the United States just as he is elsewhere, is neither the tycoon of yesteryear nor the rugged individualist of the American frontier. He is the creation of a business environment which has reached its frontier, which is more interested in stability and respectability than in getting on with the job on hand at all costs.

Exactly the same thing could be said about the modern trade union leader. The fact is that the businessman and union official of today could well take a greater interest in politics not because they have learned to be public spirited (although there is an element of this in it) but because as social types they have arrived in a respectable and respected position where business agrees very often with the poet that whatever is best administered is best.

White Collar Frays

The recruitment, training and supervision of office staff is the subject of a report by the Industrial Welfare Society which is designed " principally for directors and managers of medium-sized and small organisations who feel the need for a more systematic staff policy." It is intended for the executive who combines the personnel function with his other responsibilities.

The main conclusion drawn by the IWS is that " white collar " jobs have lost their appeal in recent years. Demand has greatly exceeded supply and employers have consequently lowered their standards and taken " whoever they could get." Few parents now encourage their children to take up office work as a career, states the IWS report. The social status of the office worker has been lowered and his economic superiority over factory workers has in many cases disappeared. The IWS report, compiled by Elizabeth M. Pepperell, provides useful guidance on how employers can help themselves.

The National Institute of Industrial Psychology (NIIP) have also been concerned with office staff problems. One of their investigations recently completed was an " attitude survey " among the managerial and office staff of the CAS group of companies. This is a type of inquiry in which skilled investigators invite managers and employees to say what they think is good and bad in their firm and how what is wrong could be put right.

The comments made are analysed and the institute makes recommendations for appropriate changes. The NIIP's findings—that there was insufficient delegation by the chairman of the group, that the clerical system, designed for complex and expensive jobs, was " unnecessarily elaborate for the smaller ones." It showed that energetic management is no substitute for good organisation and that the humble ranks of middle management, so often forgotten, play a vital part in the profitability of the enterprise.

Briton Wins Soviet Award

The Royal Society has been informed that Dr. Louis Essen, a senior principal scientific officer at the National Physical Laboratory, has been awarded the A. S. Popov's Gold Medal by the Academy of Sciences of the USSR. This award is for the most distinguished scientific work in the field of radio engineering performed during the period from 1956 to 1958. The work of scientists from all countries is considered, but this is the first time that it has been awarded to a scientist outside the Soviet Union.

The outstanding achievement which has won Dr. Essen this recognition has been his work leading to the establishment of an atomic frequency standard as a possible basis for the future standard of time which would have greater precision and be more easily accessible than the astronomical standard for the purposes of radio engineering and physics. Dr. Essen has also played a leading part in establishing that the precision of the caesium standard and the stability of propagation of low frequency radio-waves meet the demands of improved aerial navigation systems which require times and frequencies to be compared over very long distances with great accuracies.

The importance of this work was recently recognised by the presentation to Dr. Essen of the first Wolfe Award, given to the research worker considered by the Department of Scientific and Industrial Research to have made an outstanding contribution to the research work of the Department during 1958. Dr. Essen was educated at the University of Nottingham, and joined the scientific staff of the National Physical Laboratory in 1929. In his early years at the Laboratory he developed the Essen quartz-ring oscillator which is widely used in frequency-standardising laboratories and observatories. From 1940 to 1946 he worked on radio measurements at microwave frequencies and since then has applied the newly developed techniques to the field of precise measurements and standards generally.

In 1953, with J. V. L. Parry, he started work at the National Physical Laboratory on an atomic standard of frequency. His recent success has established him as a leader in this field of fine measurement, which is the prime responsibility of the Standards Division of the NPL, of which he is a member.

Teaching by Machine

The possibility of teaching and training by machine is being taken very seriously in the most responsible scientific quarters in the United States. A recent issue of the *Industrial Bulletin of Arthur D. Little* one of the most authoritative and reliable scientific reviews in the world, calls for " a technology of education that will increase the efficiency of the teaching process and use available manpower most economically."

Recalling that teaching machines which enabled the student to take an active part in the teaching process (automatic multiple-choice testing devices which also taught by scoring responses immediately) were designed in the 1920's and 1930's by Sidney L. Pressey, the bulletin describes the work now proceeding at Harvard under the leadership of Professor B. F. Skinner.

Some of the advantages of machines as teaching devices are that they are very quick in providing the student with his results; that they save teachers the tedious labour in marking tests; and that they enable individual students to work at their own speed. Professor Skinner's group have programmed and tried out a number of different teaching devices presenting materials in psychology, languages and mathematics at college, high school and elementary school levels.

Other work is also being done by several colleges and universities in cooperation with public and private schools and certain governmental agencies responsible for training large numbers of personnel. Programmes are being written elsewhere to train telephone service representatives and electronic technicians.

The machines are particularly suitable for working with verbal or pictorial material and it is in this field that most of the work has been done so far. However, states the bulletin, there is no reason why some of the same techniques cannot be used in the teaching of manipulative tasks, as are encountered in industrial training, where the operation of complex machinery and procedures must be learned.

Documentary Two

THE summary of selected Atomic Energy Authority reports begun in last week's issue is continued below. (Reports obtainable from H.M.S.O.)

Uranium

Active Fuel Cartridge Radiography

Recently declassified equipment and a method for radiography of active uranium fuel cartridges are outlined. This procedure allows examination of surfaces for pimple type defects, and detection of dimensional changes, with errors of only a few thou. The cartridges may be canned and emit up to 750 curies if of the BEPO shape—perhaps somewhat more—while using a 2-second X-ray exposure with the film in position for only 5 seconds, thus minimising gamma fogging. The apparatus was intended for use, also, with 6 in uranium bars irradiated in the Canadian reactor NRX. In fact, only a third of the gamma energy escapes from a BEPO can and the activity is 60 curies, one day after extraction, falling to about 35, ten days later. The lead shielding and X-ray arrangements are discussed. (AERE G/R366, *The Radiography of Active Uranium Cartridges*, J. A. G. Smith and J. Thewlis, 4 pages, 3 figures, 2*s* 6*d*.)

Gas Swelling of Uranium

Recently declassified, this report brings up to date an earlier report (M/R1750) for bubble swelling of irradiated uranium, and uses a theoretical treatment of quasi-viscous creep of metal near each gas cavity. Steady rates are also found for annealing of little-swelled irradiated fuel. Although different results are obtained from previous ones, they are still an order of magnitude erroneous below 700° C, being too low, for no clear reason. A bibliography is given. (AERE T/M134, *Calculations of the Rate of Swelling of Gas Bubbles in Uranium*, A. J. E. Foreman, 15 pages, 6 figures, 3*s*.)

Surface Activity of Uranium Alloys

Recently declassified results of increased surface activity (beta) of vacuum-prepared uranium ingots—the activity is related to segregation of thorium isotope at the surface due to preferential oxidation. Counts up to 25 times normal are observed, but the active oxide film can easily be removed by nitric acid etch, and then the uranium can be handled safely for twice as long as usual. The phenomena were first found in molybdenum alloys when microscopic sections included a portion of surface. This segregation was found from beryllia or magnesia crucible melts, and with copper alloys. From half-life data the count was traced to a thorium isotope oxide layer, with consequent depletion in the bulk metal activity. Basically, the effect results from a greater oxidation reactivity of thorium—perhaps by reaction with the crucible. (AERE M/M12, *The Surface Activity of Various Uranium Alloy Ingots*, J. Redfearn, B. W. Mott, 4 pages, 1*s* 9*d*.)

Thorium Alloys

Data on Thorium Alloys

A recently declassified review, up to 1952, of the alloys of thorium, their preparation and properties. Remarkable instances of the variation in published data are two figures for melting point published in 1949 (1,850 and 1,140° C). Zirconium, hafnium and rare earths should form the most extensive solid solutions, and generally thorium crystal structures should be similar to those of cerium and uranium. A certain solubility, as in the case of uranium, occurs in liquid aluminium. A long list of references and tables of data are given. Presumably more up to date data exists on some topics. (AERE M/R 2242, *The Preparation, Properties and Alloying Behaviour of Thorium*, Miss. J. R. Murray, 35 pages, 5*s*. 6*d*.)

Thorium-Magnesium Alloy Analysis

In their binary alloys thorium and magnesium can be determined by direct titration with EDTA using xylenol orange as indicator. The magnesium can be measured, after removing thorium as peroxide in acid solution, by titrating with EDTA, also using solochrome black indicator. Magnesium even in heavy excess does not affect the titanium analysis under acid conditions, but thorium does prevent the magnesium determination with normal indicators, and so must be removed. Eriochrome black T may also be used for the magnesium indicator, preferably under slightly less alkaline conditions, and in either case tartrazine screening helps. Some references are given. (AERE C/R2527, *The Analysis of Thorium-Magnesium Binary Alloys*, G. W. C. Milner and J. W. Edwards, 5 pages, 1*s* 9*d*.)

Plutonium

Detecting Plutonium Traces

Recently declassified, this report discusses relative advantages of alpha counting and neutron irradiation in-pile techniques for accurately estimating small amounts of plutonium. Uranium must be absent, and detection of fission products rather than fission may be best, but then almost complete freedom from tellurium before assay is essential. Possible gains in sensitivity over alpha counting are estimated. (AERE C/M 23, *Detection of Plutonium by Irradiation in the Pile*, H. A. C. McKay, 3 pages, 1*s* 2*d*).

Plutonium Estimation

The accuracy and precision of lanthanum fluoride coprecipitation of plutonium is studied and available data reviewed. A number of measurements suggest 97·4 per cent accuracy, using solutions made up with uranium to correspond with practical working solutions. Details of techniques are given—and a bibliography. (AERE C/M327, *A Study of the Accuracy and Precision of the Lanthanum Fluoride Coprecipitation Method for the Determination of Plutonium*, R. B. Chenley, G. J. Hunter and T. J. Webber, 11 pages, 1*s* 9*d*.)

Structures of Plutonium

X-ray diffraction photographs were taken from ambient temperatures to 530° C for plutonium, and the method and results are discussed. Data for the crystal structures of delta and epsilon phases are tabulated and their structures interpreted. Declassified two years ago, the results do not agree with United States reports of a sixth phase. Three impurities were found in all results—due to plutonium oxide and dioxide, as well as calcium oxide. The two phases chosen are the only ones with simple X-ray patterns—thus delta is a face centred cubic, and epsilon a body centred one. Explanations are attempted of the changes in atomic diameter of plutonium in terms of electron structure. A bibliography is included. (AERE M/R2416, *The Crystal Structures of Plutonium: Delta and Epsilon Phases*, J. G. Ball, P. Greenfield, P. G. Mardon and J. A. L. Robertson, 11 pages, 1 figure, 2*s* 6*d*.)

Fission Products

Computing Reactor Fission Products

The programme was written for the Mercury computer. Limitations on fission product data are that the number of intermediate reactions in one chain leading to any given end product should not exceed 20, and the number of different chains of reactions should not exceed 475—when the computer eventually has all eight memory drums in operation. The calculation is performed on a logarithmic time scale specified by giving the number of points required over the scale and the time range in days. Thus as six points are specified over the range 1 to 243, the calculation will be carried out for 1, 3, 9, 27, 81 and 243 days. A maximum of 32 points is allowed for. Fuel is assumed to be uranium 235. (AERE T/M 174, *A Program for the Calculation of Fission Product Accumulation*, by E. G. H. Crouch, 10 pages, 2*s* 6*d*.)

Fission Product Removal

Radioactive effluent treatment columns, especially those using soils, are investigated; in particular the use of a local green sand at Harwell. The treatment follows sludge blanket precipitation which normally leaves about 4 per cent remnant comprising 40 per cent ruthenium, the rest being caesium. All the latter and most of the former are removed by columns giving 99 per cent overall efficiency. Using long columns, decontamination factors of a thousand are possible. The green sand is much improved by additives such as polyelectrolytes, silicones and quaternary ammonium compounds, but it is concluded that vermiculite, being almost ideal, is far better. A ferrous sulphide blanket seems to be effective for ruthenium removal. Detailed tables of results, references and graphs are included. (AERE ES/R 2220, *The Removal of Fission Products from Solution with Precipitator-Column Treatment: Part 1 Laboratory Trials*, K. G. Seedhouse, J. Monahan and G. Wallis, 32 pages, 5 figures, 5*s*.)

Ruthenium Separation

A recently declassified report on the chemistry of ruthenium with respect to plutonium separation. Results for small-scale experiments on copper coprecipitation, as sulphide, and, also with graphite, charcoal and antimony sulphide columns. Although a graphite column process is more efficient than butex cycles, it is considered to be too difficult from an engineering viewpoint, owing to difficulties in filtering sulphur and sulphide precipitates in practical effluent solutions. A few references are given, and graphs of removal efficiency against several variables. (AERE C/R 2413, *The Chemistry of Ruthenium with Reference to the Plutonium Separation Process: Part 4. The Sulphide Treatment for Ruthenium in the Uranium Stream*, G. L. Miles and F. S. Martin, 16 pages, 8 figures, 3*s*).

Neptunium Recovery at Windscale

Spectrophotometric studies of neptunium in solutions similar to those at Windscale indicate that the use of hydrazine for reduction is complicated by its destruction due to the catalytic effect of iron. But partial success in recovery of the 237 isotope from highly active effluent is achieved by reduction to the tetravalent state followed by ion exchange. Complete details of results and method used are given along with graphs. (AERE C/R 1893, *Chemical Studies Relating to the Recovery of Neptunium from the Windscale Plant*, E. Hesford and H. A. C. McKay, 18 pages, 9 figures.)

Effluents

Exercise Mermaid: Winfrith Effluent

Experiments are described with extremely detailed results, on the dispersion of soluble fluorescent dyes in the sea at Arish Mell Gap, Dorset. This operation was to simulate the proposed discharge of liquid radioactive effluent from the Winfrith site. The report suggests the optimum outfall position and supplements Admiralty data on tidal streams in the area. Floats, with and without drogues, were also used to check large-scale eddy effects, as well as batches of floating plastics envelopes. In particular, it is suggested that the pipe might be two or more miles long and shoreward drift would aid dispersion. If timing is correct the St. Albans race can be used to disperse out to sea, otherwise effluent will go via Portland Bill. Sea bed roughness was investigated to give pipe laying data, and fauna study initiated, especially of lobsters. Comparison with Windscale conditions show the situation to be generally more favourable. Temperature and salinity variations were investigated to determine any gradients likely to aid dilution during the autumn of 1956 when the local gunnery range was not active. The coast is generally rocky with little sand and fairly deep water close in—all indications of strong water currents. Seabed surveys indicated a rock ridge barrier investigated using Admiralty personnel by echo-sounding and underwater survey, with clays noticeably absent. There are double tides of about twice the Windscale velocity, and two large eddies are outlined, in part the cause of the shoreward drift. No variation in salinity or temperature were detected, possibly owing to disturbed conditions during measurements, but perhaps due to the absence of any large rivers feeding the region. Using Decca navigation, ship plots were accurate to six yards. From Windscale data, and the local indication of 1,670 hours per year as maximum time spent by lobster fishers near their gear, and assuming the pots take up a tenth of the sea bed activity (twice that attained by trawls), the maximum seabed level can be fixed as 0·016 microcuries per gram. The shore concentration may be ten times as high as at Windscale and must allow anyone to be safely on the beach 100 hours a year at low water level. The suggested figure for shore sand and seaweed is double that given above. Since it appears some people (gourmets?) eat up to ½ lb of lobster a day, the maximum concentration to be allowed in the edible parts is suggested at 500 micro-microcuries per gram. Minimum dilution near the pipe would be 4,000 and it would seem safe to discharge 25 kilocuries per month, at two miles, although this would be most unlikely to be authorised, and further restrictions on alpha emitters and on the total of strontium 90 and ruthenium 106 would be expected. Some suggestions on further models and full scale trials are given, along with a bibliography, detailed mathematical and experimental details in appendices, as well as tables and charts. (AERE E/R2628, *Exercise Mermaid*, P. Bowles, R. H. Burns, F. Hudswell and R. T. P. Whipple, 125 pages, 79 figures, 16 halftones, 35*s*.)

Underground Fission Waste Cooling

Recently declassified calculations are given for determining the temperature of deep-buried clay-contained fission waste, with tables for the effect of many common fission products, arranged for easy use to give approximate temperature increase

estimates for given concentrations in curies. The premises made are discussed, and cerium is considered the most important heat contributor. (AERE C/R1294, *The Cooling of Underground Fission Wastes*, J. K. Perring, 10 pages, 2*s* 6*d*.)

Radium in Effluent Monitoring

A recently published report written some years ago concerning estimation of radium at very low levels in effluent containing other alpha emitters, and in urine. Known methods are critically discussed, and lead sulphate followed by barium chloride coprecipitation gives almost quantitative recovery from low to very low concentrations, with good decontamination from its daughters and fuels, in about three hours. Effluent discharged in May, 1953—for example for the Thames—showed only 12 micromicrocuries per gallon of radium—about 3 per cent of the total alpha. List of references, data and graphs are included. (AERE C/R 2385, *The Monitoring of Effluent for Alpha-Emitters: Part* 3 *Radium*, E. N. Jenkins and G. W. Sneddon, 24 pages, 5 figures, 4*s*.)

Estimation of Radiostrontium in Effluents

A declassified summary of methods for estimating radiocalcium and radiostrontium in effluents—the main aims being speed and that any errors should be ones of slight over-estimation. The general aim is to bring down the strontium with calcium. In practice something like 99·5 per cent success is achieved and with practical effluent, traces of barium, algae, phosphate and other constituents will be present, leading to a slight over-estimation, which is preferred. The technique is described in detail and works whether the effluent contains excess lime or phosphate and in the presence of a small amount of tannate. A bibliography and several graphs are included. (AERE C/R 1902, *A Method for the Determination of Radiocalcium and Radiostrontium in Effluent*, B. A. Loveridge, 24 pages, 5 figures, 4*s*.)

Early 1958 Bone Strontium

The results for 1957 were not directly comparable with those of 1956, because the samples were drawn from districts of widely varying rainfall. But the 1958 samples here reported are from the same areas as those of 1957. Comparison is now valid, and shows a slight increase in the median S.U. levels. The highest values are again in the 0-5 year age group. The natural strontium content increases with age. (AERE C/R 2816, *Radioactive and Natural Strontium in Human Bones: UK Results for Early 1958*, F. J. Bryant, E. H. Henderson, G. S. Spicer, M. S. W. Webb and T. J. Webber, 4 pages, 1*s* 9*d*.)

Radiation Chemistry

Isolating Isotopes

All these isotopes have been ordered from the Isotope Division. The beryllium, manganese, promethium, and vanadium isotopes were made in the Harwell cyclotron, the strontium in the Birmingham cyclotron, and the remainder by the (n, γ) reaction, followed by beta decay, in nuclear reactors at Harwell. (AERE I/M 53, *The Production and Separation at AERE Harwell of Beryllium 7, Manganese 52, Promethium 148, Vanadium 48, Strontium 85, Gold 199, Silver 111, Protoactinium 233*, C. E. Mellish and J. A. Payne, 4 pages, 1*s* 2*d*.)

Fixing Nitrogen with Alpha Particles

A series of reactions is suggested as a best explanation of the results observed. Agreement between the results predicted by the proposed overall mechanism and previous experimental results is good, and, by making use of the proposed theory, the values of G_{NO_2} and G_{NO_3} for air have been calculated and their variation with oxygen-nitrogen pressure ratio investigated. (AERE C/R 2802, *A Theoretical Interpretation of the Alpha Particle Induced Combination of Nitrogen and Oxygen*, F. Moseley, 27 pages, 7 figures, 5*s*.)

Anthracene Fission Decomposition

Analyses are given for gases evolved in anthracene by fission fragments from uranium obtained by irradiation of a mix of anthracene and uranium dioxide in BEPO. For similar energies, it is found that fission fragments are 27 times as effective as pile irradiation in liberating hydrogen, but the rate falls off with time—perhaps due to depletion of nearby hydrogen. Carbon dioxide and monoxide are also formed, together with acetylene and other hydrocarbons. The material was inserted as a powder under vacuum in a silica container—the oxides presumably come from reaction with urania, and results were taken up to almost 1,000 MW hours. A short bibliography is included. (AERE C/M290, *The Gases Evolved During the Decomposition of Anthracene by Fission Fragments*, D. F. Sangster, 7 figures, 1*s* 9*d*.)

Carbon 14 in Reactor Coolant

Carbon 14 in Calder Hall type coolant is determined by absorbing the gas in saturated barium hydroxide solution, then regenerating the carbon dioxide, and after purification, submitting it to a beta proportional counter. The method was developed by the Chemical Services Department of Windscale. Full details of the technique are given. (IGO AM/W113, *The Determination of 14 Carbon in Reactor Coolant Gas*, Chemical Services Department, Ops. Branch, Windscale, 9 pages, 2*s* 6*d*.)

Chemistry

Preparing Deuterium Sulphate

Details are given for one method of making small amounts of concentrated pure deuterium sulphate. Difficulties and possible improvements in this and other possible techniques are considered. (AERE C/R 2386, *The Preparation of Deuterium Sulphate*, D. E. Glanville, 2 pages, 1 figure, 1*s* 2*d*).

Magnesium Determination

A technique is described for spectrographically determining magnesium in bismuth uranium alloys, giving a 5 per cent variation coefficient at 300 p.p.m. The alloy is converted to oxide, pelletised with ferric sulphate and excited in a d.c. arc. This method is a variation on the iron-flux technique, and is intended for use with liquid-metal fuelled reactors, wherein zirconium and calcium must also be analysed: there are difficulties in analysing them simultaneously, by normal spectral methods. (AERE C/R 2456, *The Spectrographic Determination of Magnesium in Bismuth-Uranium Alloys*, J. C. Cotterill, 7 pages, 3 figures, 1*s* 9*d*.)

Radiation and Spectrometry

Lectures in Radiation Measurement

A series of six detailed lectures devised in 1950 for use at Harwell for senior scientific officers, assuming a slight experience of electronic equipment. They are entitled the detection and measurement of radioactivity. Some worked examples are given, together with profuse circuit diagrams. The main topics discussed are: detectors, amplifiers, counters and regulation. (AERE EL/L3, *The Application of Electronics to the Detection and Measurement of Radioactivity. A Course of Six Elementary Lectures*, H. Bisby, 21 pages, 67 figures.)

Beta Counting Correction for U and Np

Results are given for the correction factor needed in beta counting of uranium 237 and neptunium 239, caused by internal conversion electrons and window absorption, using a standard assembly. Several methods of checking the data obtained are given. (AERE HP/R2383, *A Note on the Beta Counting of U237 and Np239*, N. G. Stewart, 3 pages, 1*s* 2*d*.)

Neutron Spectrometer

A recently declassified design of a helium 3 fast neutron spectrometer, with details for its application as a proportional counter. With powerful discrimination against gamma radiation, it measures neutrons from 0·1 to 1 MeV with a resolution of 3 per cent; and the wall effect though largish, agrees quite well with expectations. Resolution could be further improved by increasing gas pressure, removing tritium from the helium 3 and using an anticoincidence ring to null the wall effect. References are included. (AERE N/R1499, *Helium 3 Fast Neutron Spectrometer; Part 1 The Proportional Counter*, R. Batchelor and R. Aves, 16 pages, 9 figures, 3*s*.)

Proton Source

Details are given of a high current (10 mA) proton source for linear accelerators at 10 kV, and small enough to be focused by electrostatic lenses; but high pumping speeds are needed. A few references, halftones, diagrams and graphs are included. (AERE GP/R 1190, *A High Current Proton Source*, P. C. Thoneman and E. R. Harrison, 16 pages, 13 figures, 4*s*.)

Gas Discharges

Gas Discharge Instability

A recently declassified mathmatico-physical consideration of hydromagnetic instabilities in viscous cylindrical gas discharges. This continues an analysis previously published which had assumed no viscosity, when it appears disturbances of shortest wavelength are the most unstable. This cannot be true, however, when viscosity is present, and in fact a mode of maximum instability exists and an approximation is obtained to the corresponding wavelength. This result is only in the form of an equation since certain numerical data are not available, in particular the relevant mean free path. An estimate of accuracy can be obtained by analogy with the hydrodynamic Rayleigh-Taylor instability. These results are still only an approximation to real conditions since there will only be finite conductivities in practical plasmas, and the strong magnetic fields present will effect transport coefficients. A short bibliography is given, as well as very detailed mathematical appendicies. (AERE T/R 1888, *Hydromagnetic Instabilities of a Cylindrical Gas Discharge:* 2 *Influence of Velocity*, R. J. Tayler, 38 pages, 5*s* 6*d*.)

Stability Criteria

Another mathematical treatise on hydromagnetic instabilities of a cylindrical gas discharge, with reference to axisymmetric perturbations, using a method developed at Princeton. Stable configurations exist when the current flows entirely on the surface of the discharge, but finite resistivity causes the thickness of the current layer to increase, with eventual instability. For one evolutionary sequence this is shown to occur when this thickness reaches about 15 per cent of the discharge radius, and approximate stability criteria are derived for non-evolutionary forms. The basic mathematical idea is to determine whether the potential energy of the system increases for a perturbation—thus immediately giving criteria for stability. It is believed that sometimes in practice thermal conductivity is too low to equalise plasma pressure and temperature, which are initially at maxima near the surface. Some of the more complex mathematics are being coded for solution by electronic computer. Graphs, tables of data and a few references are given. (AERE T/R 2503, *Hydromagnetic Instabilities of a Cylindrical Gas Discharge: Part 6. Energy Principle Calculations for Axisymmetric Perturbations*, M. H. Boon, E. W. Lang, J. Randles, S. J. Roberts and R. J. Tayler, 39 pages, 6 figures, 6*s*.)

Stabilised Annular Pinch Theory

A mathematical note on the theory of stabilised pinches, shows that their stability is due to the coexistence of plasma and magnetic fields at the centre. The analysis shows that an annular discharge with an axial magnetic field at its hollow centre is unstable against perturbations of increasing annular amplitude. All hollow discharges are not unstable, however; thus one with cusped cross section is stable. A short bibliography is included. (AERE T/M158, *A Note on the Stabilised Pinch*, R. J. Tayler, 4 figures, 8 pages, 1*s* 9*d*.)

Wriggling Discharge with Conducting Walls

A mathematical analysis has been completed on the influence of conducting walls on the wriggling of gas discharges—assuming infinite wall conductivity. Plane sinusoidal and helical configurations are considered; the induced currents in the walls give similar results in each case, and offer stability for small disturbances of long wavelength. This result agrees with hydromagnetic model criteria. Non-linear effects are not very pronounced until the discharge is close to the wall, and a wavelength which grows to 80 per cent of the distance to the wall is only 25 per cent less than that which just fails to grow. Other methods are needed to control short wavelength instabilities. Detailed tables and graphs are given. (AERE T/R 2138, *The Influence of Conducting Walls on the Wriggling Gas discharge:* 1 *Walls of Infinite Conductivity*, S. J. Roberts and R. J. Tayler, 35 pages, 4 figures, 5*s* 6*d*.)

Magnetic Field Diffusion in a Conductor

A discussion on the interdiffusion of axial and azimuthal magnetic fields for stabilised pinch gas discharges, of finite conductivity. Fairly simple theory suggests that loss of stability due to this diffusion occurs in a thousandth of the time for penetration—or a figure of this order, its exact value depending on the gas conductivity. The mathematics is fairly complex and a short list of references is attached. (AERE T/M 160, *The Diffusion of Magnetic Fields in a Cylindrical Conductor*, J. H. Adlam and R. J. Tayler, 19 pages, 4 figures, 3*s* 6*d*.)

Fast Pinching

A recently declassified theory of initial stages of low-density pinching following Guderley, and cylindrical geometry, including shock waves. Data for plane and cylindrical shock waves are compared, after calculations which are explained in detail. (AERE GP/R 2293, *A Theory of the Fast-Pinched Discharge*, J. D. Jukes, 14 pages, 6 figures, 2*s* 5*d*.)

Research and Development

NEWTONIAN THEORY *of* AXIAL ELASTICITY *Part 3*

By A. N. PROCTER
M.Sc., A.M.I.C.E., M.I.Struct.E.

Concluded from page 4, 7 August

The presence and effect in axially loaded materials of secondary shear stresses, that have been inferred from the results of the simple mechanical tests described in the earlier parts of the article, may be further investigated by indirect methods of research, using modern apparatus and techniques, based on some of Newton's theoretical and experimental discoveries in the realms of physics.

The concluding part of the article discusses the possibility of using photoelastic methods to estimate secondary shear strains in the interior of transparent materials. Ultrasonic testing apparatus may be used to detect the formation, location and direction of the internal cracks that appear to be produced by the shear stresses in a wide variety of elastic materials, so that the two methods of research are to some extent complementary.

PHOTOELASTIC RESEARCH

Sir David Brewster, a notable Newtonian scholar, discovered that a piece of glass under the action of a system of applied forces has double refracting properties. When polarised light having the vibrations in one plane is projected through a transparent test piece under strain, it is split into two parts. One part is transmitted through the test piece, but the other part is double refracted and is retarded. The interference obtained by the recombination of such rays of white light produces colour bands that may be projected on to a screen or photographed. W. Wertheim discovered that the retardation of the refracted light is proportional to the thickness of the test piece and to the difference of the principal stresses at a given point, but in a material which did not follow Hookes Law, the double defraction was proportional to the strain.

A number of transparent materials are available for photoelastic work and it is necessary to determine their stress-optical constants by experiment. Xylonite ($E = 0{\cdot}3 \times 10^6$ lb per sq. in and Poisson's ratio $\sigma = 0{\cdot}39$) has a stress-optical constant about ten times greater than glass ($E = 9 \times 10^6$ lb per sq. in and $\sigma = 0{\cdot}2$ to $0{\cdot}27$). Dr. R. W. Ditchburn[18 20] observes that in order to verify the stress equation completely, it is necessary to subject a specimen to a variable shearing force and it has been found to be an advantage to measure the transverse strains to determine the sum of the principal stresses. There is reason to believe that the double refraction caused by an axially loaded test specimen is probably produced by the two zones of opposed shear distortion indicated in Fig. 2, causing a part of the light to refract twice before emerging, the retardation being caused by the additional distance travelled by the refracted rays.[21]

An explanation of the splitting of light rays into two parts was given by Newton in *Opticks*, Book 2, Part 3, Proposition 12, as follows: ". . as Stones by falling upon Water put the Water into an undulating Motion, and all Bodies by percussion excite vibrations in the Air; so the Rays of Light, by impinging on any refracting or reflecting Surface, excite vibrations in the refracting or reflecting Medium or Substance, and by exciting them agitate the solid parts of the refracting or reflecting Body, and by agitating them cause the Body to grow warm or hot; that the vibrations thus excited are propagated in the refracting or reflecting Medium or Substance, much after the manner that vibrations are propagated in the Air for causing Sound, and move faster than the Rays so as to overtake them; and that when any Ray is in that part of the vibration which conspires with its Motion, it easily breaks through a refracting Surface, but when it is in the contrary part of the vibration which impedes its Motion, it is easily reflected; and, by consequence, that every Ray is successively disposed to be easily reflected, or easily transmitted, by every vibration which overtakes it But whether this Hypothesis be true or false I do not here consider I content myself with the bare Discovery, that the Rays of Light are by some cause or other alternately disposed to be reflected or refracted for many vicissitudes "

The simultaneous reflection and refraction of light at the surface of a transparent medium or substance is a familiar phenomenon and it appears probable that the simultaneous transmission and refraction of the plane polarised light through the strained test pieces is produced by the same agency The incidence of double refraction and retardation is peculiar to materials that are strained and is a clear indication of the presence of two optically oblique zones in the material, caused, possibly, by shear strain.

Materials," ENGINEERING, p. 1, vol. 111 (1921), see also reference 21. At and near the change in width of the test piece, which had a uniform thickness of 0·1812 in, the colour varied considerably, indicating variations in the distribution of the shear strains that would be expected in this region. In the uniform parts of the test piece, respectively 0·855 in and 0·4488 in wide and remote from the change in section, the colours were very nearly uniform throughout the widths, though the colour of the narrow section differed from the colour of the wide section. The colour of the narrow section was a pale blue of the first order and the colour of the broad section was reddish yellow. It is assumed, therefore, that the axial shears were nearly uniform throughout each section, although different in each section. In such cases the coefficient η of equation (1) (page 779, 19 June) would be taken to be about unity, but in intermediate sections, where the colour varied, η would be less than unity, depending on the range of the colours across the sections.

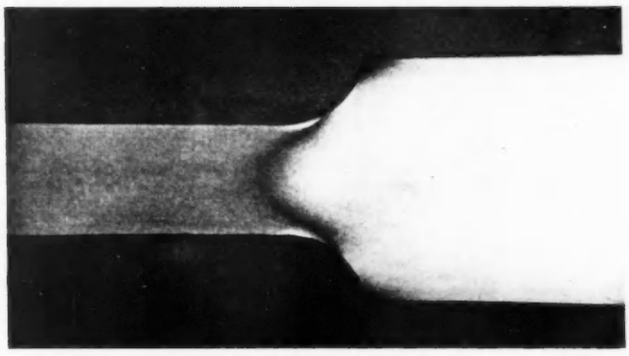


Fig. 11 Photo-elastic test on an Xylonite model of the British Standards test bar with ends of considerable width. The light-coloured bands at the commencement of the curved contours are of the second order and indicate a high stress intensity.

Newton's experimental researches in the interference effects of rays of light of different refractibility and frequency are described in *Opticks* and in Book 3, Question 13, he explains the origin of colours, one of his most important discoveries:* " Do not several sorts of Rays make Vibrations of several bigness, which according to their bigness excite Sensations of several Colours, much after the manner that the Vibrations of the Air, according to their several bigness excite Sensations of several Sounds? And particularly do not the most refrangible Rays excite the shortest Vibrations for making the Sensation of deep violet, the least refrangible the largest for making a Sensation of deep red, and the several bignesses to make Sensations of the several intermediate Colours?"

The colours produced by the mutual interference of the transmitted and the double refracted parts of the rays emerging from the polariscope are evidently the resultant effects of the differences in phase, brought about by the retardation of the double refracted parts of the rays Since the double refraction and retardation of the light is here assumed to be caused by the two zones of shear strain in the transparent material, the colours are taken to be a measure of the shear strains in it. Fig 11 is a reproduction of an illustration of a strained xylonite model of a standard tensile test piece published by Professor E. G. Coker in " Tension Tests of

* See M. Roberts and E. R. Thomas, *Newton and the Origin of Colours*. G. Bell & Sons Ltd., London (1934).

The application of photoelastic tests is somewhat limited. Only transparent materials can be used and the test pieces used in a polariscope should be preferably of flat section, since a transparent cylindrical rod deflects parallel rays without causing them to come to an exact focus. All elastic materials are, nowever, capable of transmitting sound waves and recent developments in electronics have made it possible to use this property to investigate the effects of loading on the interior of opaque elastic materials.

ULTRASONIC RESEARCH

Propositions 47 and 48 of *Principia*, Book 2, contain a typically brilliant Newtonian research into the theory of sound, that forms the basis of seismic investigations and of modern ultrasonic research. He showed that the velocity of transmission of sound through an elastic medium or substance is proportional to the square root of the quotient of the elasticity divided by the density. Thus the axial velocity of sound through a rod or tube of solid matter would be:

$$V = \sqrt{\frac{E}{\mathscr{D}}} \quad . \quad . \quad . \quad (5)$$

where E is the Young's Modulus in dynn per sq. cm and the density $\mathscr{D}$ is in gm per cc. Newton's theory was tested experimentally by W. Wertheim and others[22] and it was found that for rods of 15 different metals it gave results with an average error of $-\frac{1}{2}$ per cent

and with maximum errors of about ± 7 per cent, a reasonably accurate confirmation. For rocks, timbers and other kinds of elastic materials there is a greater range of error, possibly because the materials are more variable, but the average of a number of tests has about the same accuracy as for metals. The formula does not appear to give good results for india-rubber and some other soft elastic substances. It is generally assumed for the purpose of seismic and geophysical experimental work that the velocity of sound in a large mass of elastic material would be a function of the bulk modulus, modulus of rigidity and density,[23] and in recent investigations this has received satisfactory experimental confirmation. There is sufficient evidence available to show that the measured velocity of sound through a body may be used as a basis of comparison of the elastic properties at different depths or distances from the free surfaces.

Instruments have been developed to propagate a pulse of longitudinal ultrasonic vibrations between points on the opposite surfaces of concrete or other materials and to measure the times of transmission with an accuracy of about 1·0 per cent or better. The opposite faces of a cube or other uniform body of material are gridded at suitable intervals and the times of transmission of an ultrasonic pulse applied at each grid point are measured and recorded.

When there is a discontinuity in the material, the velocity of transmission of the ultrasonic pulses is reduced, so that it is possible to detect the formation of cracks in a test piece under load by applying axial and transverse pulses.[24] It has been found that longitudinal cracks begin to form in the interior of 4 in Portland cement concrete cubes at about a third of the crushing load, and that in 12 in by 6 in diameter concrete cylinders the longitudinal cracks begin to form at about a half of the crushing load. When concrete is tested in tension there is little evidence of longitudinal cracks forming in test pieces, but there is evidence of transverse cracking shortly before failure.

OBSERVATIONS

The results obtained from photoelastic and ultrasonic research appear to confirm the presence in axially loaded elastic materials of shear distortion and shear stresses. Photo-elastic tests on transparent materials can be considered to be strictly applicable only to amorphous materials, in which the internal stress distributions may not be the same as they would be in crystalline or metallic materials under the same conditions of loading. They might be applied with reasonable accuracy to green concrete, if the thickness and proportions of the model and the concrete are about the same, although general principles deduced from small models would probably be roughly applicable, provided that the proportions are the same. It is evident that tests on small models of any material may not give results that would be directly applicable to full-size members or structures.

Much additional information on the nature of axial stresses in elastic materials may be deduced from tests under combined or complex loading. Tests on axially loaded materials subjected to circumferential forces, biaxial tests and bending tests, all give relevant information. Investigations relating to the surface tension of solids, surface friction and other surface forces are within the scope of the inquiry.

The cause of the limit of proportion and its possible connection with the fatigue properties of materials is another line of approach. Newton's Question 31 of *Opticks* asks: "Have not the small Particles of Bodies certain Powers, Virtues or Forces, by which they act at a distance, not only upon the Rays of Light for reflecting, refracting, and inflecting them, but also upon one another for producing a great Part of the Phaenomena of Nature? For it is well known, that Bodies act one upon another by the Attractions of Gravity, Magnetism, and Electricity; and these Instances shew the Tenor and Course of Nature, and make it not improbable but that there may be more attractive Powers than these."

The relation between the strength and elastic properties of materials and their electro-chemical[3] and magnetic properties[17] and their density has received considerable attention, especially in recent years, so that there are a number of avenues along which the various problems may be approached with good prospects of success.

The phenomena referred to in this article have been attributed from time to time to various causes; generally a different cause is found in connection with a different material. Newton's first and second rules of scientific reasoning (*Principia*, Book 3) are applicable here[25]:

Rule 1: "We should not admit more causes of natural phenomena than are both valid and sufficient to explain their appearances."

Rule 2: "We should therefore, as far as possible, attribute the same causes to the same phenomena."

Acknowledgements are made to Mr C B. Brewington, B.Sc., A.M.I.C.E., A.I.Mun.E., and Mr. T. D. Hackney, A.M.I.C.E., for advice and helpful criticism and to Mr. K. Watson, A.L.A., for assistance with translations from *Principia*.

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ELECTRONIC SIMULATOR FOR REFINERY PROCESSES

A new machine which may lead to considerable improvements in an already advanced field of automatic control is to be built soon by Air Trainers Link Limited.

Known as CERES, a control engineering research electronic simulator, it has been commissioned by British Petroleum Limited to simulate various refinery operations for research studies. It will be used at Longbow House, London, where it will assist the designers of automatic control and plant systems and to investigate such problems as stress and vibration analysis.

When set up as a simulator, CERES will be able to reproduce typical or exceptional situations in controlled refining processes. Plant operators may therefore be trained to deal with a range of conditions which it would be impractical to arrange at the refinery itself. New processes may be demonstrated before the completion of the plant.

The computer is particularly interesting because it is based on 0·1 per cent accuracy in all elements. This may often be higher than the accuracy of the input data but will ensure a range of simulation of not less than four decades. Forty-eight d.c. amplifiers, of a type recently developed by Air Trainers Link Limited, will be provided in addition to 92 coefficient potentiometers. The latter will be set with the aid of a digital voltmeter, but an automatic setting mechanism may be added later.

Two types of servomultiplier are provided. One has a very fast response and the other, though much slower, is suitable for long term integration. The latter unit will be used in the simulation of processes with time constants of many hours. Both types will generate non-linear functions if required.

Other elements provided are 10 segment electronic function generators, a very low frequency oscillator which will provide a wide variety of waveforms, and a small double beam oscilloscope monitor. Two patch panels are provided which have removable plug boards giving pre-patching facilities. The whole equipment, including power supplies, will be housed in six standard 19 in racks.

CERES, by combining British Petroleum's knowledge of refining processes and Air Trainers Link's experience in simulation, may do much to bring analogue computation to the forefront in fields where digital services have previously commanded the most attention.

REDUCING NOISE

The liquid borne noise transmitted through an oil pipe can be greatly reduced by fitting a suitable silencing chamber, says a research report from the National Engineering Laboratory, East Kilbride, Glasgow.

Work has shown that a noise reduction of nearly 100 : 1 (40 dB) could be obtained with a 2 in thick lining of cellular plastics in a silencing chamber running parallel to the direction of flow. Since this type of material is only effective when its pores are air filled, it must be sealed from the oil with a thin sheet of impervious material such as polythene.

Noise reduction of machines is also being studied at NEL, where special measuring and testing facilities have been provided. The Laboratory say that they are willing to use these facilities to advise firms on the reduction of mechanical noise in their products and works. A mobile laboratory is also available.

STABILISING WOOD BY CHEMICAL REACTION

The lack of dimensional stability of wood and its vulnerability to rotting agents and insects has always been a major drawback to the use of timber in certain applications. However, since it is still an abundant, versatile and comparatively inexpensive raw material, any improvement to its stability and resistance to decay would be of considerable benefit.

With this objective, research is now being carried out at the Arthur D. Little Research Institute, Midlothian, Scotland, into a number of chemical modifications to the structure of wood cells. They report that in recent years the dimensional stability of wood has been shown to be improved by esterification and etherification reactions. By such treatments, some of the hydrophylic hydroxyl groups of cellulose and the hemiscelluloses and of lignin are replaced by more bulky and less hydrophylic groups. Thus a reduction in swelling and shrinkage is obtained by two effects: a bulking effect which keeps the wood in a permanently swollen state; and a reduction in the degree of hygroscopicity of the wood structure by the introduction of less polar groups.

So far, the problem of impregnating natural timber has not been overcome, but for the purpose of establishing chemical data, sawdust samples are being used. The samples are generally made up of beechwood since it is a relatively permeable hardwood and therefore more easily penetrated by liquids and gases.

In addition to improving resistance to swelling and shrinkage, substitution of the hydroxyl groups can result in improved resistance to biological attack by interference with the enzymes responsible. It can also reduce the combustibility by inhibiting the agent responsible for the formation of flammable tars on pyrolysis.

On the Shelf

By Frank H. Smith

Missiles and Rockets recently had an article "U.S. Seeks Ways to Close Translation Gap" wherein they start "Hundreds—possibly thousands—of scientists working on U.S. space and missile programs are wasting their time." The idea is, of course, that it's all been done before behind the ferrous drapings and they are probably quite right. But what galls them is the thought that it is probably all there in the literature. The solution? Tons of translation—preferably by machine. This business of duplication occurs all over the shop in all sorts of fields. A better appreciation of the value of librarians would go a long way to making up leeway.

I receive some rather interesting "news leaflets" from the librarian of Toledo ("Key to the Sea") Public Libraries. I am sure his locals derive great benefit and amusement from these gossip snippets but I do wish he would remember that readers abroad are not too clear where Toledo is and an address somewhere on the material would help. There are eight Toledos in my gazetteer and I expect they all think they are THE Toledo. I like his story of the shy young man who borrowed a book entitled "How to Hug," only to find that it was a volume of an encyclopaedia.

An unusual descriptive puff for a new book comes from the Technical Publishing House, Budapest. It is for Imre Pal's *Descriptive Geometry Interpreted by Stereoscopic Views*, and the first paragraph says "One of the greatest difficulties in teaching descriptive geometry is that with most people the power of visualization does not develop unaided." So in this book they provide some of those figures which give you the impression that your eyes have gone bifocal in Technicolor. Then you put a pair of green and red spectacles in front of your eyes and everything stands out. I seem to remember a celebrated young woman founding a reputation on an album of photographs of herself with which one used these rose and grass-coloured spectacles. Sorry there's no price for the (geometry) book but try getting the leaflet first; a pair of spectacles is included.

Another item for cumulative index collectors. The South African Association for the Advancement of Science (P.O. Box 6894, Johannesburg) does one for 30*s* covering their three publications 1903-53/4.

Chapman and Hall (37 Essex Street, London, WC2) announce their adoption of three American agencies—John Rider (Publisher) Inc., Consultants Bureau Inc., and Plenum Press Inc. The main ingredients are telecommunications for the first and Russian translations for the other two. The same publishers (C. & H.) have a new list for metallurgists.

In 1955 UNESCO produced Volume I of *Bibliography of Monolingual Scientific and Technical Glossaries* (only they do it all in lower case with no caps.) which covered standard glossaries. Now Volume II is out and this deals with "miscellaneous sources" which, as far as I can see, covers those not contained in Volume I. Anyway, if you have Volume I you'll obviously want Volume II and it is 12*s* 6*d* and I think you'll get it from HMSO If you *don't* have Volume I it is about time you had.

The Petroleum Films Bureau have issued their 1959 catalogue of what they have. If you want a copy write to 29 New Bond Street, London, W1, or ring HYDe Park 7565.

L.S.E. Engineering Bulletin does not, strangely enough, come from the London School of Economics. In this case it stands for Laurence, Scott and Electromotors Limited, and I expect you can get a complimentary copy if you write to Gothic Works, Norwich. The firm's products are the subject of the contents.

BAKER ON TORROJA

Philosophy of Structures. By EDUARDO TORROJA. English Version by J. J. POLIVKA and MILOS POLIVKA. *University of California Press, USA;* and *Cambridge University Press, Bentley House, 200, Euston Road, London, NW1.* (94*s*)

Some years ago at an informal dinner at the Institution of Structural Engineers, after a meeting of the International Association of Bridge and Structural Engineers, six distinguished foreign engineers were entertained. Each of the guests contributed an after-dinner speech. Though his English was halting, by far the most lucid and witty speech came from Eduardo Torroja, the great Spanish engineer and architect. It is a pity that he did not himself prepare the English version of his important book *Philosophy of Structures*, in which he sets out his reflections on structural design. He has been badly served by his translators so that the reader has to work hard to unravel many of the sentences. However this hard work will be rewarding for the engineer whose basic knowledge is already well founded. Unfortunately for the student, it may be confusing or even dangerous. At all events the engineer must not allow himself to be put off by such early sentences as that describing Cyclopean dry masonry, "As a virginal creation resulting from human struggle it is the last extant message of the first task aiming toward permanency of art and construction." He must persevere because Torroja did not write, in the original Spanish, either the woolly quasi-philosophical treatise which some structural engineers insultingly offer to architects, or a mathematical treatise on the theory of structures of which probably too many already exist. He described the functions of structures, the types available and the heterogeneous complex of considerations to be resolved by the designer. It is all buried here.

Among the gems that the translation cannot obscure are the marginal sketches, particularly those dealing with stress distribution. They are a delight and should be copied by every structures lecturer who uses a blackboard. The non-mathematical discussion of the properties of materials, the distribution of stress and the carrying capacity of structures must have been brilliant in the original. As they stand they could form invaluable material for discussion by advanced students guided by a knowledgeable instructor, though it would be hard for a student, English or American, to make anything of the following statement about the effect of notches—"Such grooves in a plate or in a bar under compression as shown in Fig. 2.5a act as kneepan under high compression and small rotation."

The absence of mathematical arguments, and some of the remarks made in passing about stress analysis and structural theory, might lead the unwary to think that the author was not a master of these techniques as he so obviously is of others. If the reader is tempted to feel this it would be salutary for him to study some of Torroja's own designs—the great 690 ft concrete arch over the Esla River at Zamora, Spain; the sports hall, Frontón Recoletos, Madrid, with its amazing slender shell roof, 3·2 in thick over a span of 180 ft; the market hall, Algeciras, a spherical shell 156 ft span resting on eight supports connected by a polygonal post-tensioned ring with cylindrical shells projecting outwards between the supports; the fascinating grandstand of the Madrid Hippodrome in which the overhanging roof, extending 43 ft over the stand is anchored to, and counter-balanced by, another and lower cantilever roof covering the betting hall. All these structures, and many others one is tempted to mention, are in reinforced or prestressed concrete, materials with which the author is probably most in sympathy. However he is no narrow specialist. One of his principal theses is that the designer must be versatile and knowledgeable enough to choose the form and material best suited to each particular problem. As proof of his own success one only need turn to the Tordera Bridge, Barcelona, with its concrete road slab acting as the compression chord of a truss all other members of which are bare steel; to the steel cantilever roof of Las Corts Football Ground, and the all-welded 595 ft span hangar at Torrejón, the complete roof structure of which, weighing 500 tons, was completed on the ground and then raised by jacks on to its supporting columns.

All forms of structure for which civil and structural engineers are responsible receive adequate treatment. In addition the author has many wise things to say about methods of construction and erection, aesthetics, calculations, organisation and the qualities required in the designer. Through the turgid translation some of Torroja's puckish wit peeps. He pokes fun at the designer who has gone out of his way to look for an imaginary functional purpose for a treatment whose originality has fascinated him or who has taken advantage of the happy coincidence that he has to design a bridge and that prestressed concrete is fashionable. He is caustic about those who feel over-confident and vain about the complexity and accuracy of their calculations—"they always carry the congenital stigma of our dubious hypotheses." Nevertheless an erroneous impression is given that someone knows all about structural behaviour—it would have been healthier in so sophisticated a work to emphasise how little is really known about the subject.

If it is not possible to recommend this book unreservedly for student use there is no doubt that every teacher of structural theory and design should model on it a course of introductory lectures. There are few practising engineers and architects who could not learn from it.

J. F. BAKER

BULK HEAT EXTRACTION

The Industrial Cooling Tower. By K. K. MCKELVEY and MAXEY BROOKE. *Elsevier Publishing Company, 110-112 Spuistraat, Amsterdam, Holland;* and *D. Van Nostrand Company Limited, 358 Kensington High Street, London, W14.* (90*s*)

In the past all the literature that has been available on cooling towers has been in the form of a series of disjointed and scattered articles published in many countries of the world. This book therefore fills an obvious gap on the engineer's library shelf. Mr. McKelvey and Mr. Brooke have set out to translate, collect, rewrite and revise all the material they could gather on the subject of cooling towers and the result is a book well worthy of its general title. The book includes many excellent charts, tables and graphs used in the design and study of cooling towers. The authors show that although the basic principles of a cooling tower may be simple, the problem of putting these principles into practice is very complicated owing to the great many factors to be considered.

With so much detail in the book one wonders whether it would not have been better to have published it in two parts, the first dealing with the thermal and theoretical design of cooling towers, and the second with their practical and

constructional design and operational aspects, because it is undoubtedly this second part which will be of greatest interest to most engineers. Cooling towers are proprietary items of equipment and very few, if any, companies are prepared to design their own, but the knowledge of what type is the best to buy, which is the best and easiest to operate, and in what circumstances, is invaluable. One fears that the relatively high cost of the book due to it containing both theoretical and practical aspects, and the fact that it contains much information not of immediate use to the practical engineer, may deprive many people of the invaluable practical knowledge it contains.

There are some very interesting chapters on cooling water treatment, timber deterioration, and similar subjects, no doubt contributed by Mr. Brooke from his experience in American industry. There are also interesting and detailed chapters on natural draught towers, particularly the structural aspect of the concrete hyperbolic type, and these no doubt derive their information from the experience of Mr. McKelvey from his work on these towers in Great Britain. Where the book falls down, however, is in its consideration of the mechanical draught tower. This was possibly to be expected considering the background of the two authors. In the book they first set out to compare different types of mechanical draught towers and then later on compare mechanical and natural draught equipment for various duties. In neither case is the full story given and this, therefore, is a failing in the book. For instance, in one section the authors compare unfavourably a mechanical draught cooling tower installation consisting of 13 or, alternatively, 16 cells, each 32 ft square, with a corresponding natural draught tower. No experienced mechanical cooling tower designer would propose the installation of 13, let alone 16, such small cells for one particular duty.

In another case the authors explain what in their opinion is the superiority of the circular tower as against the cell type and then claim that their opinion is backed up by experience in Europe. This, however, is not true as in recent years more and more use in Europe is being made of the cell type of cooling tower, and in fact one of the largest cell type installations in the world has recently been supplied for a power station in Germany.

It is unfortunate that no mention has been made of plastic packing in the section dealing with this part of the cooling tower. With all the troubles that have been encountered with certain of the timber fillings, with their thin cross-section, particularly in film flow towers, the advent of the plastic packing operating to a combined splash and film flow, is an event of tremendous interest. As this packing has been in operation in America for at least three years and some 90 installations are in existence, it is a wonder that it has been almost ignored by the authors.

However, these criticisms apart, the practical information on operating cooling towers, water treatment, timber treatment, use of concrete, and so on, is extremely invaluable and certainly make this book worthwhile to the cooling tower operator or purchaser, provided the information contained therein is used in conjunction with that gained from experienced designers of the equipment.

DEREK J. TOW

The Reviewers

Professor J. F. Baker is head of the Department of Engineering at Cambridge, where he has held the Chair of Mechanical Sciences since 1943. Educated at Rossall and Clare College, of which he is now a Fellow, he was first employed at the Royal Airship Works, where he worked on the design of the structure for the airship R.101and took part in test flights of the R.33. After two years as assistant lecturer at University College, Cardiff, he became technical officer to the Steel Structures Research Committee in 1928, and in 1932 he was appointed to the Chair of Civil Engineering at the University of Bristol. At the outbreak of war he joined the Ministry of Home Security as a scientific adviser and became head of the Design and Development Section in the Research and Experiment Department. In that capacity he was responsible, first, for the measures taken to protect industrial production and later for the design of all standard forms of air raid shelter including the Morrison shelter. At Cambridge he has continued the investigation begun at Bristol on the behaviour of structures carried into the plastic range. This work has led to the rational and economical plastics method of designing steel structures described in his book *The Steel Skeleton*. He is also the author of *Differential Equations of Engineering Science* and *Analysis of Engineering Structures*. He was awarded the Telford Gold Medal in 1932, the Howard Medal in 1937, the Ewing Medal in 1952 and the Gold Medal of the Institution of Structural Engineers in 1953. He received the O.B.E. in 1941 and is an M.A. and Sc.D. of Cambridge, a Fellow of the Royal Society, an M.I.C.E. and an M.I.Mech.E.

Mr. Derek J. Tow is deputy commercial manager in the department of Head Wrightson Processes Limited, which handles all the company's estimating and technical sales activities. He is the author of several papers on various aspects of cooling towers, and is a B.Sc. (Eng.), a Dip. Chem. Eng., an A.M.I.Mech.E. and an A.M.I.Chem.E.

NEW BOOKS

Kemp's International Film and Television Directory 1959. *Kemp's Commercial Guides Limited, 299-301 Gray's Inn Road, London, WC1.* (30*s*)

Tells you where to contact any conceivable aspect of television and Eurovision. A cross-section of the index produces "animals—live and stuffed"; "dubbing facilities"; "film strippers"; "Models puppets and display"; "stunt men agencies"; "topiary."

Drop Forging Die Design. By R. C. JONES. *Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey.* (3*s* 6*d*)

A 92-page booklet aimed at those directly engaged on die and tool design.

Fractional Factorial Experiment Designs for Factors at Three Levels. By W. S. CONNOR and MARVIN ZELEN. US Department of Commerce National Bureau of Standards Applied Mathematics Series No. 54. *Superintendent of Documents, US Government Printing Office, Washington 25, DC, USA.* (30 *cents*)

Published in the hope of accelerating the application of fractional factorial designs in experimental work. The programme was sponsored by the US Navy's Bureau of Ships.

Tables of Osculatory Interpolation Coefficients. By H. E. SALZER. US Department of Commerce National Bureau of Standards Applied Mathematics Series No. 56. *Superintendent of Documents, US Government Printing Office, Washington 25, DC, USA.* (30 *cents*)

"Computed to facilitate interpolation when both a function and its first derivative are tabulated." Osculatory, here, is a mathematical term.

Dechema Monographien No. 426-450. Band 31: Laboratoriums-Technik. Published for *Deutsche Gesellschaft für Chemisches Apparatewesen EV., Frankfurt am Main*, by *Verlag Chemie, GmbH, Weinheim, Bergstrasse, Germany.* (26.25 *DM*)

Summaries at the end, in English and French, give titles and abstracts of the 25 papers, on such subjects as sedimentation, a new hydrometric balance, high-frequency titration, automatic analysis equipment, analysis equipment, electrophoresis, high-vacuum distillation.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Handling

Fork Trucks. HYSTER CO., 2902 N.E. Clackamas Street, Portland 8, Oregon, USA. SpaceSaver series lift trucks with cushion tyres and capacities up to 5,000 lb. The Monotrol system of control that they use is described in a separate brochure.

Side Loaders. CLECO ELECTRIC INDUSTRIES LTD., Cleco Works, Foundry Square, Leicester. Side loading fork trucks with capacities up to 6 tons and 10 ft lift; battery driven. Platform aperture takes 48 in pallets; four wheel steering. Various leaflets.

Lifting Magnets. RAPID MAGNETIC MACHINES LTD., Lombard Street, Birmingham 12. Liftmaster lifting magnets in three sizes for loads up to 2½ tons of pig or 15 ton skull cracker ball. Leaflet.

Lifting and Shifting. G. HUNTER (London) LTD., 80 Fenchurch Street, London, EC3. Catalogue covering cranes, hoists, lifting tackle, jacks, conveyors, stackers, etc., with sections on the design of despatch bays and roller conveyor systems.

Hoists. AABACAS ENGINEERING CO. LTD., Birkenhead. Cranes, single girder, underhung, travelling, box lattice, crabs, etc.; and hoists, electric and hand travel in various forms. Catalogue gives dimensions and examples of use.

Permanent Magnets. DARWINS LTD., Fitzwilliam Works, Sheffield 9. Permanent magnets for lifting, holding and positioning; horseshoe, round or square. Booklet.

Drum Handling. POWELL & CO., Burry Port, Carms. Drum Master handling equipment for drums, barrels, carboys, bins, etc., including trolleys, barrows, stackers, loaders, and tippers. Publication DBC4.

Overhead Cranes. CLAYTON CRANE AND HOIST CO. LTD., Irwell Chambers East, Union Street, Liverpool 3. Overhead cranes of all sizes. Examples are given in an illustrated brochure.

Suspension Magnets. RAPID MAGNETIC MACHINES LTD., Lombard Street, Birmingham 12. Deep field electric suspension magnets for extracting tramp iron. Leaflet No. 130.

Elevator Chains. AUTOMATIC COAL CLEANING CO. LTD., Durranhill, Carlisle. The Acco Bloklink chain for constructing elevators and conveyors. Leaflets.

Conveyor Idlers. FISHER AND LUDLOW LTD., Bordesley Works, Birmingham 12. The Flexiroll system of conveyor idlers is claimed to give improved belt life, need no lubrication, and to have no fire risk. Illustrated brochure.

Lift Table. TIPTON WELDED FABRICATIONS LTD., Great Bridge Street, West Bromwich, Staffs. The Zeeta folding lift table, hydraulically operated; portable and stationary models, three sizes to lift up to 4,000 lb. Leaflet.

Straddle Carrier. HYSTER CO., 2902 N.E. Clackamas Street, Portland 8, Oregon, USA. The M300E straddle carrier has a capacity of 30,000 lb and is said to include many improvements. Leaflet.

Midget Hoists. A.C.E. MACHINERY LTD., Porden Road, Brixton, London, SW2. Low cost midget hoists for construction work; hand, petrol, or electric operation. Ground or scaffold mounting. Catalogue.

Idlers. MAVOR AND COULSON LTD., Farme Cross, Rutherglen, Glasgow. Idlers and rollers for conveyor belts from 14 to 60 in belt width; cushion rollers, steering idlers and troughing. Catalogue 703 gives range and dimensions.

Bottom Loading. AVERY-HARDALL LTD., Oakcroft Road, Chessington, Surrey. Automatic bottom loading equipment for vehicles carrying liquids in bulk. Spillage is avoided; float control of level in each compartment. Illustrated booklet describes the system.

Side Loader. LANCERS MACHINERY LTD., 41 Knightsbridge, London, SW1. Side loaders with capacities up to 6 tons and stacking heights of 14 ft; loads can be 70 ft long. Leaflet.

Overhead Conveyors. BRITISH MONORAIL LTD., Wakefield Road, Brighouse, Yorkshire. Catalogue of overhead handling equipment including details of the MonoRail system and its components, track, switches, runners, etc., lifts, and cranes. Examples of installations and charts of loadings are included.

CERAMICS MADE FROM GLASS

Promise Dry Bearings and High Strength

In May, 1957, Corning announced the discovery of a new family of fine-grained crystalline materials made from glass. These materials are called glass-ceramics, and products made from them are designated by the trade-mark Pyroceram. They are made by a process of controlled crystallisation, from special compositions containing nucleating agents.*

Glass-ceramics appear worthy of attention for their new and useful combinations of properties and for their basically new manufacturing process.

The batch ingredients, including the nucleating agent, are mixed and melted to a homogeneous glass. This can be formed by conventional glass-forming methods, such as pressing or blowing into moulds; drawing as tube, rod or pipe; rolling or drawing into flat sheet; or centrifugal casting. The more fluid glasses may be cast into intricate shapes by methods similar to metal-casting. The glass ware is cooled. At this point it is transparent, and readily inspected for flaws or bubbles. Some compositions can be reheated and reworked into new shapes while still in the glassy state.

A carefully controlled high temperature heat treatment causes first the precipitation of billions of submicroscopic crystal nuclei; then growth of these nuclei until the glass article is converted (substantially unchanged in size or shape) to the fine-grained crystalline product Pyroceram. The crystals in Pyroceram are normally smaller than 0·0001 in in diameter, and are randomly oriented. Usually a small proportion of glass is interspersed with the crystals.

Although it is possible to reproducibly form glass-ceramic articles to reasonably close tolerances requiring no further finishing in many cases, some high-precision shapes do require finishing. Glass-ceramics are capable of being ground and polished to very accurate dimensions by the methods used for glasses, ceramics, and hard metals.

The unusually fine-grained and uniform structure has important consequences for some mechanical applications. It contributes to the unusually high strength, and also to extremely smooth wear characteristics. The material can be polished to an optical surface (one of its promising applications is in making astronomical mirrors that do not change shape with temperature). In applications such as bearings, it never releases abrasive particles but wears smoothly.

Glass-ceramics are non-porous and generally have an opaque white appearance in the finished state, though some compositions may also be transparent like glass. They are resistant to high temperatures in terms both of strength and oxidation. They are like glasses in their ability to resist chemical attack with measured durabilities in weight loss ranging in values comparable to the durable chemical glasses. They are lighter and harder than most metals. In thermal conductivity they are classed as heat insulators. The thermal expansion coefficients range from negative values, through zero to positive values of 110×10^{-7} per °F. Hence extreme heat shock resistance and dimensional stability with temperature may be had by choice of composition to provide coefficients of expansion near zero.

In electrical properties glass-ceramics are classed as electrical insulators having dielectric constants from 5 to 10 and power factors at high frequencies ranging down to extremely low values. In mechanical properties these materials are generally higher in Young's modulus than glasses, ranging from 12·5 to some 20×10^6 lb per sq. in with strengths higher than glasses and most ceramics. Glass-ceramics are not ductile or malleable as are most metals, but are classed as brittle materials.

Various compositions can be tailor-made to meet desired properties, with the final control depending on special heat treatment. Two compositions in various forms and types or product are now available commercially. These have code numbers 9606 and 9608 and their properties are listed in Table I together with values for two commercial glasses and high purity alumina for comparison.

The first use of glass-ceramics has been in radomes for supersonic missiles, where a radar-transmitting material having a combination of strength, hardness, temperature and thermal shock resistance, uniform quality, and precision finishing is required.

The second large-scale application is in "heat-proof" skillets and saucepans, again taking advantage of the thermal shock resistance.

One of the products of potential interest to mechanical engineers is bearings for operation at high temperatures without lubrication, or in corrosive liquids. Another is a lightweight, dimensionally stable honeycomb structure which has promise for use in heat regenerators for gas turbines operating at high temperatures.

Since glass-ceramic bearings might be expected to be stable at high temperatures, resistant to oxidation and to corrosive conditions and area light in weight, a thorough evaluation of their characteristics is being made by a number of laboratories and bearing manufacturers. One of the surprising findings has been the discovery that glass-ceramic bearings can be finished almost as easily as steel bearings.

Bearing systems of various types, combining Pyroceram with such materials as Hastelloy C, Stellite 3, and titanium carbide, have been successfully operated dry at temperatures from 1,000° F to 1,800° F in some cases, under conditions that caused the best all-metal systems to seize or fail, see Table II.

Tests have been made to determine the compression load that Pyroceram can endure in a thrust bearing. These tests indicate that Pyroceram fails in a brittle fracture at about the same compressive stress that causes steel to flow. This stress is about 380,000 lb per sq. in.

Similarly, combinations of Pyroceram with itself and with accepted corrosion-resistant metals such as Hastelloy B or Stainless Steel 304, were run successfully in corrosive liquids, showing lower coefficients of friction, and lower wear, or lower surface damage than Hastelloy B running against itself. The liquids investigated were concentrated solutions of nitric acid, sodium hydroxide, citric acid, ferric chloride, 30 per cent hydrogen peroxide, and molten lead at 700° F.

It has been found that friction and wear of Pyroceram sliding or rolling against itself without lubrication are rather high, and that it is more satisfactory to use it in combination with certain metals.

To summarise, it appears that Pyroceram bearings have great promise, particularly as a dry bearing material and for use in corrosive media. Maximum safe loadings and life times are still being investigated.

The thermal shock resistance and the dimensional stability of the low expansion glass-ceramics make them useful in various kinds of heat exchangers. One interesting type has been developed for use in high-temperature turbine engines.

As requirements for precision instruments and machines become more stringent, the gauges and machine tools required to make them must become still more precise in dimensions. If these are made of relatively high expansion metals such as steel, the dimensions vary with temperature. The expansion coefficient of Pyroceram Code 9608 between 0° C and 100° C is so nearly zero that no measurable change in length occurs in this temperature range. For this reason, it should be a useful material for precision gauges, for the beds of special machine tools, and other parts requiring constant dimensions.

An active development programme is under way with the object of developing glass-ceramics maintaining strength to 2,500° F and higher; increased strength, hardness, and wear resistance; tailormade compositions having expansions to match various metals. Combination of these materials with methods of precision casting may make it possible to produce such products as lightweight turbine wheels for high temperature service.

TABLE I.—*Properties of Glass-Ceramics, Glass, and a Ceramic*

—	Glass-ceramic Pyroceram		Glass		Ceramic high purity aluminas
	9606	9608	Code 790.. 96 per cent silica	Code 7740 Boro-silicate	
General:					
Specific gravity (77° F)	2·60	2·50	2·18	2·23	3·6
Water absorption (per cent)	0·00	0·00	0·00	0·00	0·00
Porosity (gas permeability)	Gas tight	Gas tight	Gas tight	Gas tight	Gas tight
Thermal:					
Softening temperature (° F)	2,282	2,282	2,732	1,508	3,092
Specific heat (77° F)	0·185	0·190	0·178	0·186	0·181
Mean specific heat (77 to 572° F)	0·230	0·235	0·224	0·233	0·241
Thermal conductivity, 77° F mean temp. (Btu per hr × ft × °F)	2·10	1·13	—	0·626	1·25–1·40
Linear coeff. (77 to 572° F) of thermal expansion × 10^7	31·6	3·9–11·1*	4·45	17·8	40·5 (68 to 932°F)
Mechanical:					
Modulus of elasticity (lb per sq. in × 10^6)	17·3	12·5	9·6	9·5	40
Poisson's ratio	0·245	0·25	0·17	0·20	0·32
Modulus of rupture (abraded—lb per sq. in × 10^6)	20	16–23	5–9	6–10	40–50†
Hardness : Knoop, 100 gm	698	703	532	481	1,880
500 gm	619	588	477	442	1,530

* Depending on heat treatment.
† Unabraded values.

TABLE II.—*Pyroceram Journal Bearing Tests (½ in bore)*

Shaft	Temperature, ° F	Coefficient of friction
*Hastelloy C	1,800° to room	0·5–0·6
Stellite Star J	1,600° to room	0·2–0·3
Stainless 304	1,600° to room	0·2–0·25
Tool steel	1,100° to room	0·2–0·23
*Inconel X	1,800° to room	Bearing siezed

* Metals run against themselves siezed under same conditions No lubrication, speed 540 r.p.m., load 27·6 lb, time 30 minutes.

* Shortened version of a paper by S. D. Stookey, of Corning Glass Works, presented to the Metals Engineering Division of the American Society of Mechanical Engineers, 30 April, 1959, at the First National Metals Engineering Conference.

VENTILATION OF A STEAM POWER STATION

This article draws the attention of purchasers, users and manufacturers of power station plant to the advantages of having a scheme of ventilation which gives maximum plant efficiency consistent with comfortable environment for personnel.

It is unfortunately true that in not only older establishments but also in many new ones the mechanical engineer is primarily concerned with the plant while the civil engineer is concerned with the buildings; neither realises the effect which the work of the other has on the degree of comfort provided at operating stations and on the operating efficiency of the plant.

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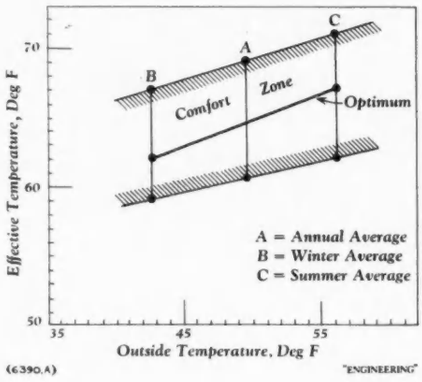

Fig. 1 Comfort zones.

POORLY ventilated stations fall into two categories: those which have virtually no ventilation at the operating stations and those where the volume of cold air allowed up through the building is excessive. As a standard of comfort Fig. 1 is used; this applies to the particular climate being considered here. The effective temperature depends on air movement, air temperature, humidity and radiant heat as measured by a globe thermometer. This standard of comfort is that used in *Heating and Ventilation in Factories* (HMSO, 1952). It is claimed that this " comfort zone " will satisfy at least 50 per cent of a group of normal people.

Desirable factors for comfort are that air movement should be provided throughout the building and that the higher the temperature and/or radiant heat, the higher the air movement desirable.

In a power station, quantities of heat are given off from the plant installed boilers, turbosets, motors, and piping, etc and this increases the temperature of the air in the building to a value depending on the heat loss from the building and the scheme of ventilation used. First, the heat given off depends on the efficiency of the insulation on the plant and it is here assumed that the economic thickness of insulation is applied. Also the heat given off is affected by the finish of surfaces, and this should be remembered when painting the boilers, turbosets and auxiliaries. As an example, aluminium paint which is suitable for use on surfaces up to about 400° F will reduce the radiant heat loss by upwards of 10 per cent as against normal oil paints.

Second, the quantity of heat given off depends on the air movement across surfaces; the temperature of the air drops with increased throughput but the total heat given off rises.

If an environment is not comfortable this can be for any one or combination of a number of reasons—the air temperature may be too high; the relative humidity may be too high; radiant heat may be excessive or air movement may not be sufficient. In a power station it is a simple matter to keep the temperature as high as desired by reducing the air flow; the problem is to make the temperature lower or to alter the air movement or humidity to compensate for high temperature. It is possible to take in the air for use in the boiler fans at a low level and use it at boiler top level; in this way the relative humidity of the air is gradually reduced as the air rises with a compensating effect for the rise in air temperature which takes place.

In this analysis for all variations of ventilation tested, the maximum wet bulb temperature at operating floor level is 65° F and in the building at any height 72° F with an outside relative humidity of up to 88 per cent. At high temperatures the humidity is the factor which has the greatest effect on comfort.

While Ireland has a moderate climate in summer (average of 56° F) the relative humidity for the year averages 85 per cent; in Fig. 3 (*c*) for example, the humidity was 84 per cent outside, 50 per cent at operating floor level and 27·5 per cent at boiler top. This drop in humidity compensates for the rising temperature to the tune of 5° F at operating floor and 8° F at boiler top.

The radiant loss from large industrial boilers is such that if copious ventilation at boiler top level is not employed, that zone would be unbearably warm and stagnant. In the older installations, as in Fig. 2 (i), the forced draught fans are at basement level and draw their air supply from the outside through doors at that level. As a consequence, it was found necessary to instal roof louvres to take away the excess heat from the top of the boiler house by natural ventilation due to the chimney effect. At the same time the engine room, which is separated from the boiler house by a dividing wall, which was originally supplied with extraction fans in the roof but no proper method of air supply to pass over the hot surfaces, was so unbearably warm in summer that a cold air plenum system was installed. Thus the advantage of having at no expense the boiler combustion air fans to ventilate the complete building was overlooked. As manufacturers improved their designs, air was taken from roof level to take advantage of the higher air temperature, but the open roof louvres remained as a relic of the older scheme. It was probably argued that, as there was a vast quantity of hot air flowing from the roof louvres, if these were dispensed with conditions would be unbearable. The mechanical engineer remained concerned with the design of the boiler unit and the civil engineer with the design of the house, but neither of them realised the effect that the work of the other had on his own. The boiler house was cold and draughty except during hot weather.

A second example, shown in Fig. 3 (*d*), is where there are very ample dimensioned roof louvres (adjustable or non-adjustable) with fan suction from boiler top level. There are, however, no openings of consequence at low level in the station and in any but the coldest weather, conditions become unbearably warm. Hot air rising from the plant passes out through the roof louvres and cold air enters at the points directly over the fan suctions. The air temperature at the inlet to the fan is lower than that at operating floor level. Ventilation depends on leakage into the building and is inadequate.

The scheme of ventilation here proposed uses

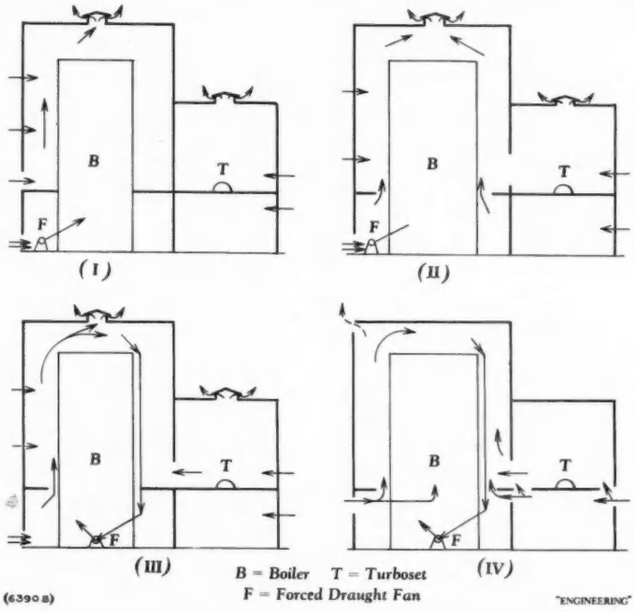

Fig. 2 Four schemes for the ventilation of a power station. (iv) *is the optimum.*

the chimney effect produced by the height of the station and the suction produced by the fan sucking air for combustion to ventilate the boiler house and engine room. In effect, air conditioning is attained without the installation of any equipment. The adoption of such a scheme at the planning stage costs very little, as the elimination of roof louvres will balance the costs; whereas if the station is already constructed with inadequate ventilation it may be costly to make alterations.

It is interesting to note that air flowing in through openings does not flow directly upwards by the shortest and easiest path to the fan suction but moves via the hot surfaces.

It is better to provide adjustable louvres for air inlet because if this is not done doors are left open, particularly those of the roller shutter type, once it has been found necessary to open them on one occasion to provide a greater measure of comfort. The custom of leaving doors open is habit-forming and should not be allowed.

Air movement is controlled and marshalled by allowing the required amount into the building through adjustable louvres over head height in the basement and letting the air rise through the building, thus providing ventilation without draughts. In this way, compensation for high radiant heat and air temperature is effected. The air movement upwards near the boiler casing and through open columns was 4·5 ft per sec on the average for the test later described in Fig. 3 (*c*). The air changes every hour vary from 1 to 8 depending on the plant in use and amount allowed to cross the engine room, which is sufficient. Fresh air is constantly entering at the bottom of the boiler house and engine room and stale air being removed from the top of the boiler house. For maintenance at boiler top level or for off-load ventilation where gases accumulate a limited number of opening windows are provided at wall top.

Thus the optimum scheme from the point of view of comfort is one where

(1) radiant heat is stemmed by the application of insulation and suitable paint,

(2) relative humidity is lowered with increase in temperature,

(3) air movement is controlled and directed to points where required.

It will later be seen that this scheme can also approach the optimum for plant efficiency.

EFFICIENCY

The provision of a scheme of ventilation which will allow the operating staff to keep efficiency at a maximum is desirable. Power station operating efficiency is of such importance that it is worth while keeping the efficiency at the highest value, consistent with comfort.

A brief summary of the familiar schemes formerly used will help in appreciation of the problem. In Fig. 2 are shown four schemes of ventilation. There are several factors involved and some are interdependent. It is to be remembered that the greater the flow of air allowed through the boiler house or engine room the greater is the heat taken from the boilers, turbosets, piping and auxiliaries; on the other hand, if sufficient air flow is not provided, conditions become unbearable.

Case (i) shows a scheme usual in older installations where no attempt was made to provide either comfort or efficient ventilation. Here cold air is drawn directly to the boiler fan, with consequent loss of the advantage of using warm air. Cases (ii) and (iii) are commonly employed; (ii) has the fan suction low down in the building while (iii) has it at boiler house top level. Case (ii) has the disadvantage that in summer, when the lower openings must be kept open for cooling of the boiler house, the fan suction cannot take advantage of the heated air passing to waste through the top openings. Case (iii) has this extra advantage; windows are indiscriminately used in (i), (ii) and (iii).

Case (iv) goes a step further; air to the fans is drawn from the engine room and from the warm air rising up through the boiler house; in this way forced ventilation of the engine room is achieved without great heat losses occuring. In addition, loss via the roof ventilators is avoided. An appreciation of the factors involved is essential for the optimum operation of this scheme and the test figures detailed later are a help. Adequate ventilation of all operating stations can be achieved in these climates with no free exit from the boiler house or engine room at high level, by drawing air through both buildings to the fan suction. It is not necessary to have personnel stationed over operating floor level; these areas are visited for routine checking.

It is not proposed to discuss here the economics or operational advantages of taking air from boiler top level in stations where the forced draught fans are in the basement; that aspect has already been amply covered in several papers. Sufficient it is to say that most stations being now built take the air from the boiler top.

The heat given off from plant can be increased or decreased by altering the scheme of ventilation. As an indication of this, consider (*a*) and (*c*) of Fig. 3; (*a*) has a heat from engine room and boiler house equipment of $13{\cdot}02 \times 10^6$ Btu per hour, whereas case (*c*) has $9{\cdot}76 \times 10^6$ Btu per hour with the same plant in use, as given in the test results below.

Too often heat balances are drawn up by assuming a value for radiation losses. In the tests carried out at average annual conditions the nett radiation/convection losses varied by 0·43 per cent; when outside air temperature and speed, and the door and window openings and number of units in service vary, the radiation loss per unit will change and it should not be left to guesswork. The calculation of this item will account in part for the mysterious fashion in which unmeasured losses vary from test to test. The task of measurement is greatly simplified by the adoption of the scheme outlined above.

The problem of ventilating power stations has elsewhere been approached from the point of view that the heat loss from the surfaces of the boiler plant of the type and size installed is 0·5 per cent of the heat input, of the turboset 1·5 per cent of output and of auxiliary plant is 5 per cent of output. From this heat loss the size of louvres and openings is designed. This gives, however, a very simplified and misleading answer.

It is startling to consider the quantity of waste heat that is emitted unnecessarily from the roofs of power stations, and indeed from many other buildings. It is appreciated that to the engineer this loss will be obvious once it is seriously considered.

To get the full advantage from the gain in cycle efficiency to be had by using the optimum scheme of ventilation the boiler must be designed for the appropriate air inlet temperature to the forced draught fan; the air heater surface must be sufficient to take advantage of the hotter air.

The application of the scheme here suggested will have an effect on the efficiency of existing stations depending on several factors, e.g.

(1) If hot air recirculation on the boiler airheater is not used, then raising of the air inlet temperature to the forced draught fans will raise the flue gas temperature and increase the fan power required, with consequent deduction in the net benefit.

(2) If hot air recirculation is being employed to keep the air heater metal to an economic temperature where corrosion is not too rapid, then by raising the air inlet temperature to the forced draught fan this recirculation is reduced; the flue gas temperature remains the same and a gross gain in efficiency due to the hotter air, the zero roof louvre loss and the lower fan power needed accrues.

TEST ON A POWER STATION

It is relatively simple to effect a heat balance to show where the heat loss from the plant in the station goes. The quantities, temperatures and

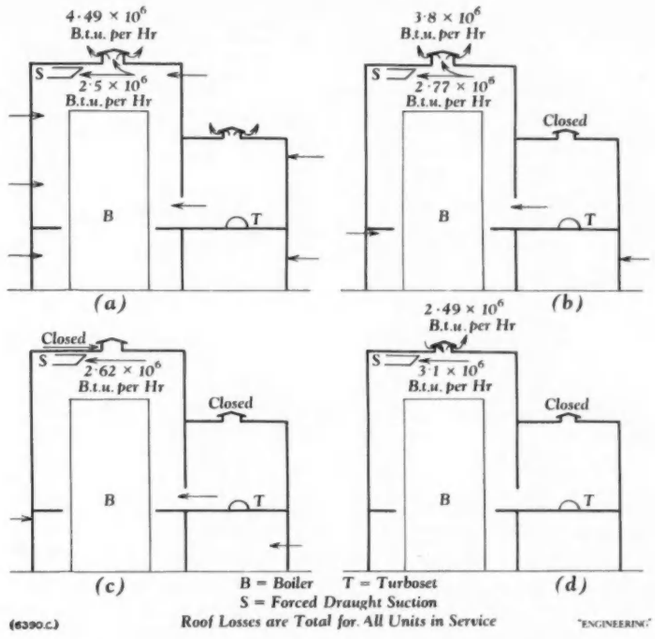

Fig. 3 Test results on a station with 60 MW of plant in service.

Fig. 3(*a*) shows conditions with the roof louvres open, and openings in the boiler house of 320 sq. ft below operating floor and 305 sq. ft above it, and 650 sq. ft in the engine room beneath operating floor and 175 sq. ft above operating floor. Conditions were comfortable at operating stations but the total heat loss from the plant was $13{\cdot}02 \times 10^6$ Btu per hour and of this $7{\cdot}50 \times 10^6$ Btu per hour returns to the fan suction of the three boilers.

Fig. 3(*b*) shows the optimum scheme with open roof louvres. Openings of 140 sq. ft beneath the boiler house floor are the only deliberate openings provided; leakage into the engine room kept conditions comfortable. In this case the heat loss adds up to $13{\cdot}93 \times 10^6$ Btu per hour and of this $8{\cdot}31 \times 10^6$ Btu per hour returns to the fan suctions.

Fig. 3(*c*) shows the position when the roof louvres are shut off. A considerable drop in heat loss is now effected and the requisite number of openings can be allowed to provide ingress of combustion air without providing excessive heat loss from the plant. In this test 280 sq. ft was found to be adequate. This showed the highest efficiency compatible with comfort. The heat loss from the plant was $9{\cdot}76 \times 10^6$ Btu per hour and of this $7{\cdot}86 \times 10^6$ Btu per hour returns to the fan suctions; an increase of 15° F in outside temperature increased the temperatures by 4° F at boiler top level and this scheme is practicable for summer and winter operation in these climates. It is more efficient than a boiler house operated with ingress via the roof only, as in Fig. 3(*d*).

Fig. 3(*d*) Here flow of air was measured in through the roof louvres to the fan suction at the same time as hot air escaped elsewhere through these louvres. The overall loss in that case was $13{\cdot}71 \times 10^6$ Btu per hour of which $9{\cdot}30 \times 10^6$ Btu per hour returns to the fan suctions; conditions were well outside the comfort zone.

direction of flow of each aperture are measured; the calculation of heat loss through the walls, roof and floor of the building is a standard calculation and figures are available for all normal constructional materials. The effect of the sun's heat in summertime is considerable where glazed construction is employed. In the station tested it is not a factor.

The heat loss from the surfaces of the plant can be computed either directly or indirectly; the direct measurement is achieved by measuring the surface temperature of each increment of surface and calculating the heat loss from each, the sum of these losses gives the total. This method raises many problems, e.g. the coefficients of heat transfer and emissivities have to be chosen, the ambient air temperatures at each increment of surface found and the total area of the surfaces of all plant with its inter-connecting ductwork and piping found. The indirect method is here employed where the radiant loss is measured as the sum of

(*a*) the heat to the forced fan suction,
(*b*) the heat loss through walls, roof and floor, and
(*c*) the convection loss through openings at a high level.

Of these three the second presents a possibility of inaccuracy comparable with the direct method of measurement, but in this case the heat involved is a fraction of the total loss and the possibility of error is correspondingly less. Outside temperatures are taken as the zero of heat gain.

The indirect method is rapid and thus lends itself to answering which of several methods of ventilation gives the lesser loss and this is basically what is of interest.

The station selected was chosen for these tests because various schemes of ventilation could be attempted by virtue of the large number of opening windows and adequate openings in all floors.

The engine room houses three Parsons 30 MW turbo-alternator sets and the roof is fitted with vents which can be closed off. The usual large shutter door is fitted in the engine room and this proved useful in varying the amount of air allowed into the engine room. The passageway from engine room to boiler house is open along its entire length over operating floor level.

The boiler house houses four B & W FH 200,000 lb per hour boilers; the roof is fitted with conventional louvres which, on test, are not very effective in aiding the chimney effect in the building because, when a strong wind is blowing, it enters on one side and blows out the other, thus greatly reducing the effective area. These louvres were, for part of the test carried out, blanked off to simulate conditions with shut or no louvres.

Throughout the test three boilers and two turbosets were on load, the last boiler and turboset being under construction.

A series of tests was carried out to show the difference in heat given off by plant and the degree of comfort attainable with variations in the scheme of ventilation. A test was also carried out to show the effect of closing off all openings but the roof louvres. In this case temperatures at operating floor level reached an effective temperature of 78° F and after a time personnel complained of lack of ventilation; conditions were clearly unbearable.

The test results are given in the Appendix.

RESULTS

Fig. 3 is a synopsis of a series of tests carried out at 90 per cent boiler load while outside temperature, wind speed and humidity were very close to the annual average for Ireland; these are 49·2° F, 8·8 m.p.h. and 85 per cent respectively. The total heat given off from plant varied from $13{\cdot}93 \times 10^6$ Btu per hour to $9{\cdot}76 \times 10^6$ Btu per hour, depending on the scheme used.

The difference in nett heat loss from the station buildings between case (*a*) and (*c*) is $3{\cdot}62 \times 10^6$ Btu per hour which, for the particular test done, represents 0·43 per cent of the cycle efficiency. In the station tested the hot air recirculation on the air heaters was employed; thus the adoption of (*c*) resulted, in addition, in less hot air recirculation and a slightly lower fan power. The losses are a higher percentage at lower loads as the heat given off does not fall off in proportion to the load decrease. This gain is very real and is one which will not be minimised through ageing of the plant in the station. This scheme is thus attractive to the boiler maker who can quote a higher efficiency when the ventilation scheme is stipulated; it is also of prime importance to the boiler user as, for example, in the case quoted above where in the station in question 0·43 per cent efficiency represents approximately £67,500 capitalised saving over 25 years' use. There are other advantages, such as less clogging of air heaters by virtue of having the air entering the fans at the highest practicable figure, or alternatively, smaller air heaters required to prevent clogging in winter time; the former is better than raising the air temperature by hot air recirculation because streaming is difficult to prevent in the latter case.

COMPARISON OF BUILDINGS

From these tests it is clear that an outdoor plant is not as attractive as might at first sight appear. The loss of $5{\cdot}52 \times 10^6$ Btu per hour would be greatly exceeded where free air circulation is allowed at the surfaces; the average wind speed at the station tested is 10 m.p.h. in winter and 8 m.p.h. in summer; no saving or advantage by using warm air at the forced draught suction is possible. Even the difference between $5{\cdot}52 \times 10^6$ Btu per hour and $1{\cdot}9 \times 10^6$ Btu per hour (see Appendix) which is but part of the saving possible by virtue of having an enclosed house, is sufficient of itself to make housing of such plant the more economic; the advantages which are in these climates virtually a necessity are thus economically available.

Plant with far greater insulation would thus be required for economic outdoor use and it is probable that an air encased boiler casing would be necessary in these climates to make the proposition more economic than a housed plant.

The economic comparison of various forms of building materials is also important. Power stations are built in a variety of materials varying from glass-clad walls to brickwork construction As a comparison the total heat loss from the station tested was, in Fig. 3 (*c*), for example, $1{\cdot}9 \times 10^6$ Btu per hour at average annual conditions, the station being constructed of concrete walls. Had this station been glass-clad from 9 ft above operating floor level upwards, the heat loss would have been $3{\cdot}0 \times 10^6$ Btu per hour. Thus the heat loss from the building must be considered in choosing the building material. The price difference between the cheaper and the more durable forms of construction is narrowed down and the latter with its long life and low maintenance costs becomes more attractive than when considered on initial cost only.

APPENDIX

TABLE.—*Test Results, Heat in Btu per hour* $\times 10^6$

Conditions, as in Figure	3 (*a*)	3 (*b*)	3 (*c*)	3 (*d*)
Heat loss through louvres	4·49	3·80	Nil	2·49
Heat returned to fans on 3 boilers	7·50	8·31	7·86	9·30
Heat loss from structures	1·03	1·82	1·90	1·92
Total loss from plant	13·02	13·93	9·76	13·71
Nett loss from station	5·52	5·62	1·90	4·41

Acknowledgement.—The author wishes to express his thanks to the Electricity Supply Board of Ireland for permission to publish this article, and to those in its employ who furthered the carrying out of the tests in November, 1956.

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BOOSTER RELAY

A booster relay (Model 61H), made by Sunvic Controls Limited, Aldwych, London, WC2, is likely to improve the design of process control loops, by making it possible to increase valve stroking speeds without losing stability.

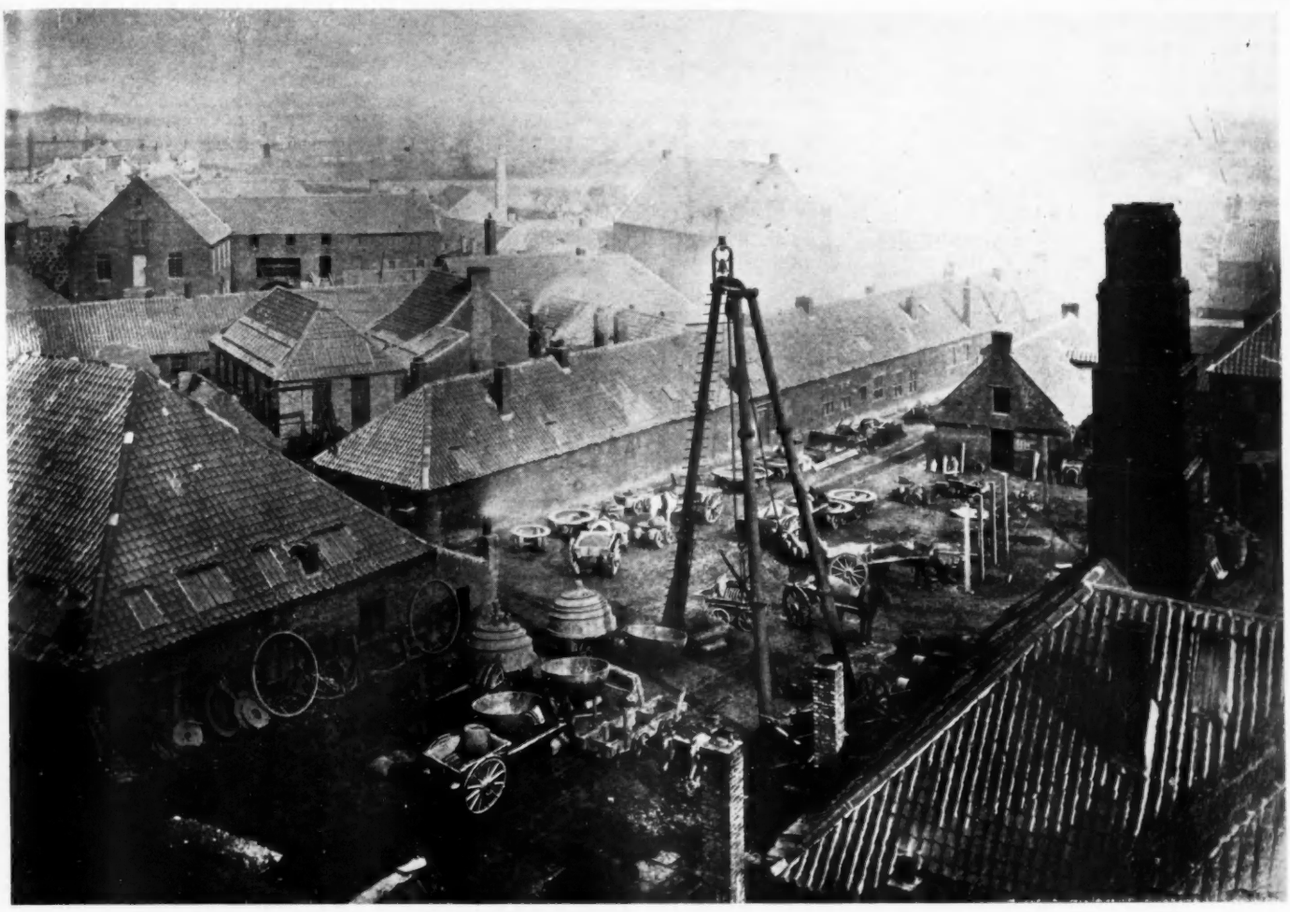
Major time lags in any automatic control loops occur at the diaphragm control valve, where large volume flows of air have to be handled. For example, a 1 in stroke valve, with 64 sq. in diaphragm top, might take half a minute to stroke fully, when receiving its signal directly from a controller. This time can be reduced by using a valve positioner incorporating volume amplification, but time constants will still average approximately 10 seconds. Also volume amplification can lead to instability and oscillation.

By using the new 61H relay in conjunction with a high precision valve positioner applied to a 1 in stroke valve with 64 sq. in diaphragm top, it is possible to stroke the valve fully in 1·5 sec, without any tendency to oscillation. A high degree of stability is achieved, because the relay uses an adjustable damping feed back circuit which permits tuning response to any particular circuit.

The relay will give a 10·3 s.c.f.m. average flow for 3 to 15 lb per sq. in change and 13·5 s.c.f.m. for a 15 to 3 lb per sq. in change. When used with Sunvic's own valve positioner, 0·7 per cent of full valve stroke causes a 12 lb per sq. in valve pressure change. The relay can be used without a valve positioner when speed (but not positioning accuracy) is essential.

Model 61H will accept input pressure up to 100 lb per sq. in so that far higher valve stroking speeds than those quoted above are possible. It will work in ambient temperatures from − 40° F to + 180° F. Dead spot is within 0·05 per cent of full scale; linearity within 0·4 per cent of full scale and reproducibility, when used with Sunvic valve positioner and with 4 per cent valve friction, is within 0·1 per cent of full scale.

Maximum air consumption under balanced conditions is 0·5 s.c.f.m.



No pictures of Carron in its earliest days are known to exist; this one shows the works in about 1850.

TWO CENTURIES OF SCOTTISH IRON AND ENGINEERING

Bicentenaries in manufacturing industry are rare. Such events backed by acceptable documentary evidence are even more unusual. Carron Company, Falkirk, Stirlingshire, Scotland, however, not only possess documentary proof that they have now been in operation for two hundred years, they have the distinction of having been incorporated by Royal Charter only a few years after the concern was established. Founded in 1759, Carron Company received their Royal Charter in 1773, and this Charter, which is in the company's archives, is still the basis of the management of the business.

The Charter names the business clearly: ". . . a number of gentlemen . . . have carried on an iron manufacture thirteen years, under the name of CARRON COMPANY." So it was then and so it remains today. It is not *the* Carron Company; the definite article plays no part in the title. Similarly, some of the old forms of management titles are still used. Carron Company is under the control of a Standing Committee of Voting Partners, the equivalent of a board of directors, and day to day operations are directed by a "Manager for Carron Company"; originally, and until 1873, one of the partners held this position.

Two Englishmen, Dr. John Roebuck and Samuel Garbett, and a Scot, William Cadell, were the founders of Carron Company. Roebuck, a Sheffield medical man who had turned his interest to the chemical industry, was responsible for the lead chamber process for making sulphuric acid, and had close association with James Watt in the early development of the steam engine. Garbett was a Birmingham merchant, who joined Roebuck in establishing a sulphuric acid works at Prestonpans in Scotland. Cadell, the third partner, was interested in the idea of starting an ironworks in Scotland, and as Roebuck was similarly inclined, the three men joined forces to put the idea to work.

On the banks of the River Carron an ideal spot was found. Coal, ironstone and limestone were available nearby, and the river provided not only the essential water power, but also a means of transport for finished goods to the sea.

Iron

Once the partners had decided to build the works, they wasted no time. An integrated plant (to use the modern term) was laid down, consisting of four blast furnaces, forges and equipment for making wrought iron, and by January 1760 Roebuck was able to tap the first cast of iron. There were difficulties, of course, not the least of which were those of transport and labour. Anything which had to be brought to the works from a distance took time; even the post from Birmingham, where Garbett lived, took nine days. Scotland was then industrially undeveloped, and skilled workmen so hard to find that the partners had to bring in outsiders at high wages to teach the local men such things as the art of boring engine cylinders.

Water power, or lack of it, was a source of trouble, too. As the scale of Carron increased, so did the need for power, and although new reservoirs were built to supplement the original small one, a dry summer could, and did, bring the works to a standstill for lack of water. The professional advice of John Smeaton was sought on this question of water supplies (and on other subjects as well) over a period of several years, and a steam engine was erected at Carron to pump tail water back to the reservoirs in times of drought.

Smeaton designed for Carron a boring mill for engine cylinders and cannons, a double machine of a most advanced type for its period, and was associated with several improvements to the blast furnaces. Some of the figures given in his reports* on this subject are illuminating; they show, for example, that in July 1776 four blast "machines" were in use, giving a total of 5,608 cu. ft of air per min, for which a total of 74,630 tons of water were "expended" every 24 hours.

Blast furnace blowing was a source of great difficulty, not only because of water shortage at times, but because of the inefficient design of the leather bellows used for the purpose. Smeaton turned his attention to this problem, too, and designed, in 1769, a four cylinder water-driven blowing machine with 4 ft 6 in

* Reports of the late John Smeaton, F.R.S., London, 1812.

diameter cast iron cylinders and a cast iron four-throw crankshaft.

Engineering

Almost from its inception the company was involved in engineering as well as in the production of iron; engine cylinders, its own blowing machinery and cannons, which had to be bored as accurately as possible, are examples of the early engineering work which came to Carron. Cannon making was to develop in the year 1778, into the production of the famous "Carronade" gun, which was the most destructive weapon of its time, throwing spherical missiles of varying weights with great effect. Carronades achieved great fame over a period of years, being used on Nelson's Victory, and finding favour with Wellington, who specifically asked for guns of Carron manufacture having, as he said, ". . . had enough of sieges with defective artillery."

It was to Carron, too, that Major General Henry Shrapnel brought his first designs for the explosive shell which gave a new weapon to military science and a new word to the English language. Shrapnel shells were cast at Carron in about 1800, and tested on a firing range nearby under the personal supervision of the inventor.

From Dr. Roebuck James Watt sought financial assistance in perfecting his separate condenser which was to revolutionise steam engine practice, and a small experimental engine was erected near Kinneil House, Roebuck's residence a few miles from Carron, in 1769, the year of Watt's original patent for the condenser.

Roebuck, unfortunately, soon got into financial difficulties with his many industrial commitments, and it is a well recorded matter of history that his interest in the engine was transferred to Matthew Boulton at Birmingham. So the Watt connection with Carron, which might have developed into a large business, was terminated and Watt disappeared from the local scene.

Carron did not share in Roebuck's financial troubles—he had, in fact, ceased to be a partner in 1786, disposing of his shares in order to raise money for his other concerns—but it is recorded that the remaining partners had troubles enough of their own at that time. Two hundred years of continuous operation cannot be all plain sailing, and Carron was to experience other difficult times as well, but it weathered them all.

Transport

One of the difficulties facing any large-scale manufacturer in the latter half of the 18th century was that of transport. Carriage of goods by road was slow, costly and uncertain; if the goods were large it was often next to impossible, at least over long distances. It is not surprising, therefore, that Carron Company should use water transport as far as possible. A short canal was made from Carron works to the River Carron, and barges loaded at the works were towed to nearby Carronshore, where the contents were transferred to coastal vessels for shipment to London and other ports.

From this it was but a short step to shipowning and in October, 1765, the sloop *Carron*, Captain Porteous, sailed to London with guns, plates, sugar pans, sad irons, ovens, stoves and kitchen backs—the first of many Carron cargoes in a Carron ship. In 1782 the company bought out a competitive shipping concern, which though it used the title Carron Shipping Company, was an independent line. The owner of the line took to privateering which he evidently found both more satisfying and more profitable, leaving Carron to carry on with the more prosaic business of delivering the goods. In this they acquired a fine reputation, though running a shipping line could at times be anything but a routine matter. The east coast route followed by Carron ships was a favourite hunting ground for French privateers, and an advertisement for a Carron sailing in 1779 shows that passages were offered to men solely on condition that they would "engage to assist in defending themselves" and would deposit a small sum of money with the captain for their provisions. Small arms were provided on the ships, which were also defended by Carronades.

Carron Company were also associated with steam navigation, for it was at Carron works that the engines for William Symington's pioneer steamer *Charlotte Dundas* were made in 1789.

Ironmongery

It could be said of Carron Company throughout their long history that if an article could be made of iron, Carron would make it. John Adam, one of the four famous architect brothers was an early partner at Carron, and much ornamental domestic ironwork was cast to the designs of John Adam and his brothers Robert and James; these products included some particularly fine dog grates, and brought Carron to the forefront in the field of domestic heating, a line which continues in production in different forms, to the present day. Similarly, decorative panels designed by William and Henry Haworth, pupils of Sir Joshua Reynolds, were cast at Carron, and a broadsheet issued by the company after a visit to the works of Benjamin Franklin, the American politician and inventor, in 1771, showed that they were interested in his "Philadelphia" stoves.

So through its first formative and sometimes difficult years Carron progressed steadily, making iron from the local ores and fuel and casting it into any form in which it could be considered useful or ornamental; engine parts, domestic hardware, holloware, machinery and millwork parts, fittings for ships, ordnance, castings "for the trade," to use the modern term, all came the way of Carron, and the works were developed steadily to meet the demand.

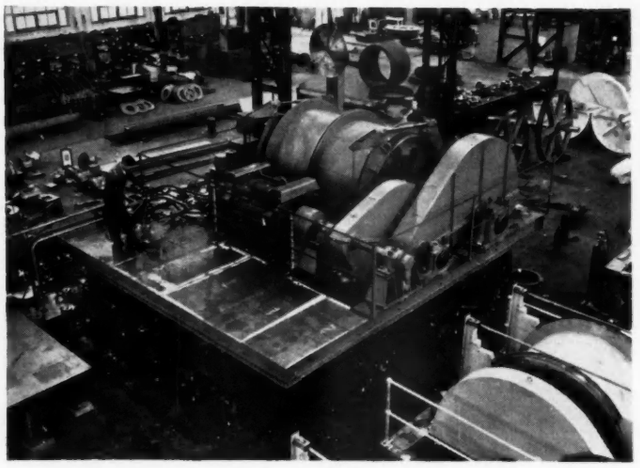
Changes

As time went on fashions changed, old products were dropped and new ones took their place. Some of the purely decorative work was out of vogue by about 1860, but six years later there came a new product, produced in moderate numbers at first, but indicative of the changes to come. This product was the cast iron bath made at the time "becomingly japanned" or in a de-luxe version "stylishly marbled." Baths remained a rarity until piped water became more common, and it was not until about 1900 that the practice developed of having a separate room for the bath. Nevertheless, the bath had come to stay, and today it is an important product of Carron works, porcelain enamelled now, of course, and very different from its ancestor.

Between 1873 and 1883 the works were almost entirely rebuilt. Further modernisation took place in about 1890, and a year or two later baths, sinks and basins were being supplied in porcelain enamel finish. In 1899 an ambitious scheme was carried out, the building of a completely new foundry an a separate site to supplement the then existing plant. This venture, the Mungal foundry, at a short distance from the old works, was soon in production on a range of castings for the building industry. Thus Carron acquired yet another new line, which is still in production.

Markets were still changing. The nation's demands for engineering products were expanding, and to establish themselves more firmly in this field, Carron Company built a further completely new works, the engineering works, near to the Mungal foundry. Built in 1899–1901, the engineering works were equipped with a machine shop, forge, non-ferrous foundry and erecting shop, and new products, including colliery haulage gear, were added to the company's range.

A department for the production of heavy duty catering equipment was added to the works in 1903, and domestic electric cookers were first marketed in 1910.



Today, engineering, as symbolised by this colliery haulage gear, is one of several branches of Carron Company's business.

In both World Wars Carron undertook, as did many other engineering firms, work which was well outside their normal range, and although Carronades were things of the past, munitions of many kinds were made in vast numbers.

The Present

At the end of the Second World War Carron had to face the task of rehabilitation, and the first effort was devoted to the mechanisation of the foundry equipment to meet the overwhelming demand for castings, particularly for the building and engineering industries. The company's coal mines and coke ovens were lost as a result of nationalisation in 1946, and in 1947 the Carron shipping line was merged in London Scottish Lines Limited, in which Carron Company hold an interest.

Today Carron Company have their main works on the original site, Mungal foundry and the engineering works nearby, and continue in the manufacture of foundry pig iron and castings in almost endless variety. The principal product groups are: domestic, including solid fuel and electric cookers, firegrates, stoves, electric fires and baths; heavy duty catering equipment of the type used in hotels and ships; general castings for the engineering and building trades; and engineering finished products. This latter group includes colliery haulage gear, ship saloon windows and shiplights, deck fittings, drop forgings, hand forgings and pipe flanges. In addition, the engineering department undertakes the complete manufacture of machines to customers' requirements.

Such is Carron in 1959. It has been said with truth that no works is ever completely up to date, and the company starts on its third century in the same spirit as it was founded 200 years ago.

Operation and Maintenance

OUTBOARD MOTORS EARN THEIR KEEP

What do the words " outboard motor " suggest to most people? Pleasure boating comes easily to mind; beyond that the purpose of the ubiquitous outboard motor is not always so obvious. And yet ubiquitous it certainly is, so it must be capable of earning its keep in many ways. A survey of the practical uses of the outboard motor conducted by Outboard Marine International SA, and published in brochure form,* shows how deeply this type of engine has penetrated into the industrial and commercial life of the world.

Because the outboard motor is self-contained, easily fitted to and removed from almost any kind of boat with little or no adaptation, and easy to transport, store and service when it is not being used, it has many advantages over the inboard engine. It can be obtained in various power ratings, can run continuously at maximum or minimum speed as required by service needs, and can be fitted with electric generating equipment for running the starter and the boat's lights and horn. Because the power unit and propeller overhang the stern of the boat and the engine itself is used for steering, space which would otherwise be occupied by an inboard engine and steering gear is saved for cargo or passenger carrying. In addition, the outboard motor has a high reputation for reliability, and servicing facilities are available in most parts of the world.

As a result of its versatility the outboard motor is now used in countless ways, ranging from the more obvious ones of propelling pleasure boats and fishing craft (often in places and under conditions where the inboard engine could not be used) to lesser-known applications such as logging and harbour tug work.

TRANSPORT

Apart from its use in passenger transport the outboard motor is applied to the movement of goods of all kinds; indeed, it has been used for every type of water propulsion with the obvious exception of sea-going vessels. Taking vegetables to market in Holland, ferrying cars across rivers in the United States, loading and unloading cargo vessels off the coast of Central America in places where there are no harbours capable of taking the bigger vessels, collecting copra in the South Seas, all come easily to the outboard motor powered craft.

Among the more unusual uses for the motor is that of propelling a 70 ft by 25 ft steel scow on a lake in Texas, USA. Designed for servicing oil wells on mounds in the lake, the scow is propelled by four 25 h.p. motors, mounted on outriggers, two at each corner of the square stern of the vessel. The motors are synchronised in pairs, and the scow is easily steered by reducing the power output of one pair of engines and increasing it on the other. With one pair of engines going astern and the other going ahead, the scow will turn in its own length.

Logging provides another example of unusual but successful use of outboard motors. A boat powered by a standard engine, with the propeller protected by a steel cage is used for sorting and moving pulp logs, and the same boat can tow large log rafts. Outboard motors have been mounted in a well in a simple flat-bottomed boat and arranged to swivel through 360°; in this way the boat can be made to travel in any direction at the will of the user, to push or pull logs or rafts as required. Outboard motors have even been used successfully clamped to a slab of wood cut from a tree.

HARBOUR WORK

Pile driving, pier construction, dredging, maintaining moorings, salvage; all provide applications for the outboard motor. An advantage here is that special-purpose boats which are only used occasionally can have their power units attached for service at any time, and removed for use elsewhere as soon as the job is done.

Harbour, lake and river towage are fields in which the outboard powered boat is finding increasing use. Given smooth water and not much wind such boats will handle surprisingly large loads. Sand and gravel barges, with a load of over 1,000 tons, for example, are regularly moved by small outboard motor powered tugs in the Long Island region, USA. These small craft have the advantage that they will go into smaller spaces than the normal tug would do and are, of course, considerably cheaper to operate. By taking over the harbour manoeuvring and the making up of a multiple tow, the small craft frees the larger tugs for the job for which they are best suited, towing the train of barges to its destination.

* Entitled " Outboards at Work ", the brochure is available, free of charge, from Outboard Marine International SA, Nassau, Bahamas.

TRAINING IN RADIATION DANGERS

Preliminary plans to extend knowledge of radioactivity and to train the specialists needed to deal with radiation hazards have been announced by the United Kingdom Atomic Energy Authority. The problem of national needs in this field has been under consideration since June, 1958, by a committee on training in health and safety appointed by the Authority with Sir Douglas Veale as chairman. This step was taken following recommendations made by one of Sir Alexander Fleck's committees set up by the Prime Minister after the Windscale accident. Two interim reports have already been given to the Authority by the Veale Committee. The final report is expected later this year.

The first interim report recommended special post-graduate courses at universities to train graduates in science or medicine to undertake specialist posts in the field of radiological health and safety. It is expected that two such courses will be available in London University by October, 1959, one run by the Royal Marsden Hospital and the other by the Middlesex and St. Bartholomew's Hospitals, jointly. The possibility of similar courses at Birmingham and Edinburgh Universities and the Royal Technical College, Salford, is also being discussed. It is possible that the scheme will be expanded later. The second report recommended a summer school to be held this year at Oxford for people who, although not engaged on full time health and safety duties, need some knowledge of the problems involved. Invitations to attend the course, which will be at New College in August and will be sponsored by the Oxford Extra-Mural Delegacy and the Atomic Energy Authority, are being sent to candidates sponsored by Government departments or official organisations. It is regarded as a pilot scheme and because of this and the fact that numbers will be limited, it will not be possible to accept individual applications. Those invited are expected to include Medical Officers of Health, Local Government Officers, Hospital Administrators, some senior civil servants and representatives of industrial managements. The question of whether a national training centre is desirable is still under consideration by the Committee together with the part to be played by the Atomic Energy Authority, universities, colleges of advanced technology and technical colleges in the training of experts.

Marketing

Appetite for Agencies

A gradual freeing of imports into this country is causing something of a stampede on the part of foreign manufacturers to secure good agencies to sell their products. Two such arrangements announced recently concern machine tools and engineers' equipment. Flexible Drives (Gilmans) Limited, of Smethwick, have been appointed sole agents for " Tyrolit " profile grinding wheels and shapes and " Tyrolit " Secur cutting-off discs in the United Kingdom and the Commonwealth.

Stanley Howard Limited have been granted the agency in Great Britain for the whole range of machine tools manufactured by Eugen Weisser and Company, Heilbronn-Neckar, Germany, including " Goliath " high speed lathes and the new " Multivert " range of vertical lathes, which are being introduced for the first time in this country.

How to Sell to Canada

Considerable emphasis on the expansion potential of the Canadian market is placed in the introduction to a booklet entitled *A Guide to Marketing in Canada* issued recently by Crawfords Advertising Service of Toronto, Ontario, in conjunction with Crawfords International Advertising. The reasons given for the publication is " the belief that many British manufacturers, realising the economic significance of the St. Lawrence Seaway development are now seriously considering establishing a position in Canada, or expanding their existing interests there.

As the title suggests, this booklet does not set out to do more than provide an introduction to the Canadian market and to indicate the salient features of marketing and advertising in Canada. The intention has been to provide a general background picture of the market for all manufacturers alike. With this as a basis, detailed information on specific products and markets can be provided to meet individual requirements. Copies of the booklet are obtainable from W. S. Crawford Limited, Overseas Division, 16 Gate Street, London, WC2.

Foot in the Door

The great importance of exports to American industry—at a time when American exporters are losing ground to competitors from other nations—was underlined in an article published in the April-May issue of the du Pont magazine, entitled " Doing Business with the World." In 1958 about one in every eight of du Pont's sales dollars was earned outside the United States. While this is not high for a British or German company of comparable size and status it is considerably more than is associated with " in-trading " American business.

Du Pont have thirteen plants in seven foreign countries, which together produced about two-fifths of the $250 million of foreign sales; exports to 110 countries made up the remainder. New plants are rapidly being added: one making finishes was recently commissioned in Cuba; others to make neoprene and polyethylene in Northern Ireland and in Canada; a finishes plant is being erected in Belgium and one to make " Orlon " acrylic fibre is to be built at Dordrecht, Holland. In Britain a research laboratory for the development of elastomers is nearing completion at Hemel Hempstead.

This pattern of overseas manufacture combined with exports, with the former in a dominant role, seems likely to become adopted by most large US concerns. It is already so in the case of motor cars and is spreading to machinery and equipment. Behind it is the conviction that trade between countries will continue to grow, and the feeling that American enterprise can

only find new outlets for major expansion outside the US. Du Pont's foreign sales rose by 23 per cent between 1956 and 1957 and by a further 5 per cent in 1958, they have come to mean the difference between break-even and profitable operations.

Machine Tools at Brno

Machine tools are to be the highlight of the Brno Trade Fair which will be held from September 6 to 20. They will take up over 40 per cent of the total exhibition area of 125,000 square metres and will include exhibits from several West European countries, including Switzerland, France, Italy, Denmark, Sweden and the German Federal Republic. Other exhibits are products in the field of heavy engineering, power engineering and transport equipment.

The Brno Fair promises to be the largest and most impressive display of engineering products from Russia, China, Czechoslovakia, and other Iron Curtain countries. As the president of the chamber of commerce of Czechoslovakia, Ing. Frantisek Adamek states in a letter included in the May-June issue of *Czechoslovak Foreign Trade* (a well produced and most informative publication) the fair will provide good opportunities for meeting trade representatives from Communist countries. The accent will be on the technical rather than the commercial; and special technical congresses will be held in Czechoslovakia during the fair.

Announcement by Invitation

Getting the customer to the factory is becoming a popular method of informing interested parties of new products as well as a means of reminding them of the firm's established products. Ottermill Switchgear Limited recently invited a party of electrical engineering consultants. The visit took place when work was in progress and a new range of oil circuit-breakers was inspected. They were received by Mr. H. M. Drake, chairman of the company, and Mr. E. H. Miles, joint managing director. Parties of four or five persons, accompanied by technical representatives of the company then made a leisurely tour of the factory and a close examination of the methods of manufacture and the components used.

A further visit is planned for the autumn and the company will be glad to hear from any consultants or engineers who would like to join the next party. Transport, which was organised by Ottermill Switchgear, was by train from Waterloo, with lunch provided. The party returned to London after tea.

Air Freight to Hong Kong

BOAC began an all-freight service between London and Hong Kong at the end of last month. The new service is operated on the corporation's behalf by Skyways Limited with Constellation aircraft on a routing London-Zurich-Beirut-Karachi-Rangoon-Bangkok-Hong Kong. This follows the trend towards the extension of all-freight air services which has gathered so much momentum over the past two years

At Home

GUARANTEED

"This article is guaranteed against bad workmanship or faulty materials." Probably the majority of items bought nowadays carry this or a similar label, usually including a promise of replacement in the event of a fault occurring within a specified time. The limitations of the conditions should be noted. Nothing is said about the article performing its function correctly or indeed at all. The customer has to find that out for himself.

Under Common Law the purchaser of an article that does not perform the implied duty has some measure of redress against the maker. But Common Law can be an expensive and tedious proceeding, with the result that most people are content to accept the limitations imposed by the written guarantee, which they do by signing the card. After all, as a general rule the purchaser can see or try the article and judge for himself whether it does the job. What he cannot see is the quality of the work or of the material that has gone into it. He is therefore probably justified in signing away his Common Law rights for the very pertinent fact of a replacement if something goes wrong. A bird in the hand is worth two, or even more, in the (legal) bush.

Many articles carry brand names; these of themselves mean precisely nothing as regards quality for they imply no particular standard. The only "guarantee" is that the maker's reputation may be at stake, but since in many cases the name of the maker is not known to the casual purchaser, this again means very little—at least for the first purchase. After that "once bitten twice shy" applies. Equally useless as any guarantee of quality are stamps like "made in Sheffield." They mean precisely what they say and no more. Indeed, they may be definitely misleading for, to take the example quoted, at one time there was a town in the far east devoted to the production of cutlery which happily adopted the name of "Sheffield"—for business reasons.

In a different category are the seals of approval used for instance by "Tide," "Lux" and Courtaulds. These do imply that a certain standard has been reached, albeit not always a published one. All three, the last perhaps most, rely on the reputation of the firm, while the first and the last have, or are, instituting periodic checks of goods purchased in shops. It should be noted that the Tide and Lux seals refer only to the washability of the fabric on which they appear; they do not necessarily apply to the whole of a garment which may include items (lining, buttons) that do not pass the test. But the presence of such a seal is at least a little guide to the consumer.

The seal of the Good Housekeeping Institute carries more weight, although here again the tests and the methods of applying them are not generally published. The Institute is, however, an independent body with a high reputation to maintain. It has the power to purchase samples of goods bearing its seal for the purpose of carrying out checks and to recover the cost of goods so obtained. The seal for each article is renewed yearly. On the whole its tests refer to the reliability of the product when in use. In the event of any complaint the Institute stands by its refund or replacement guarantee and will act as go-between for customer and maker.

The only mark for which tests are rigidly and exactly laid down and for which the testing details are available to the public is the "Kitemark" of the British Standards Institution. From the point of view of the consumer, however, even this has some limitations. For instance, it certifies that a minimum standard of performance has been attained but gives no idea of whether it was exceeded. The Kitemark scheme does not operate for all Standards referring to consumer goods and the Institution claims that the Standard must be an "all round" one before the mark becomes applicable.

The way would therefore seem open for some sort of legislation which would give a "rating" to seals of approval and to guarantee marks. It was possible with these considerations in mind that the Board of Trade have decided to set up a Committee on Consumer Protection under the chairmanship of Mr. J. T. Molony, Q.C.* The committee has these terms of reference: "To review the working of the existing legislation relating to merchandise marks and certification trade marks, and to consider and report what changes, if any, in the law and what other measures, if any, are desirable for the further protection of the consuming public."

The terms of reference are wide. Since they mention legislation it would seem that they would also include the rather vexed question of prosecution in the event of an article falling below the standard indicated by the mark; in other words, the committee might have to deal with the problem of the one faulty article among a thousand good ones, and decide how to allot the responsibility. Obviously if a manufacturer claims that his goods are tested to a certain standard and it is found that they in fact do not meet those requirements, then he should be held liable; his remedy is to raise the average sufficiently to allow for the natural variation, particularly where the raw material is itself rather variable in quality. Alternatively, he can introduce a rigid test system and sell those items which just fail as "seconds"—a practice already in existence among many firms. Such a practice suggests the introduction of grades. The terms of reference would seem to be wide enough for it.

The purchaser must always decide which model serves his need best. Unfortunately it does not seem possible for the committee to take action against such statements as "tested by the AB bureau," which can be perfectly true yet deliberately misleading if the two vital words "and rejected" are omitted.

* The composition of the Committee as at present announced is: Mr. Bedford Attwood, chairman of a firm of management consultants and of Television Audience Measurement Limited; Mrs. Leslie Beauchamp, housewife; Mr. Rex Cohen of Lewis's Investment Trust and Selfridges Limited; Mr. Beryl Diamond, wife of the Headmaster of Cardiff High School; Lord Geddes, company director, member of the Scottish Gas Board, Scottish Tourist Board, and Board of the British Travel and Holidays Association; Mr. Bernard Kenyon, clerk to the West Riding Council; Mr. Edward Lewis, chairman of the Decca Group; Mr. John Ramage, director of the Drapers Chamber of Trade and treasurer and secretary of the Retail Distributive Trades Conference; Miss Agnes Richmond, assistant secretary Scottish Trades Union Congress; and Mrs. Dorothy Stone, wife of a London solicitor. One member is yet to be appointed—a lawyer.

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